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THE MATHEMATICS TEACHER

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THE MATHEMATICS TEACHER

Volume XXXVII Number 5

Edited by William David Reeve

In Defense of Donald Dull

By MARY A. POTTER
Racine, Wisconsin

OF COURSE it is a time honored custom for teachers to complain about the quality of the material from which they must produce results. You know the hoary story of the high school teacher who said, "No, I can't teach Donald *one thing*. It's the fault of his junior high school teacher. She didn't teach him anything. I have to have some kind of a foundation to build on."

When charged with her failure, the junior high school teacher defended herself: "It isn't my fault. I couldn't teach him anything either, because his elementary school teacher let him slip through her hands without acquiring any information I could find."

The elementary school teacher said, "Donald Davis? Of course he doesn't know anything, but he didn't get the right start in the kindergarten."

It was the kindergarten teacher's turn to pass the blame for his failure. She had said, years before, "Mrs. Davis, I believe Donald wouldn't have so much trouble with his work if you had only taught him something at home before he came to school."

But Mrs. Davis had her alibi, "Land sakes, Miss Turner, it ain't my fault and it ain't Donald's fault. He's just like his dad's folks. The Davises is all dumb."

Thoughtful teachers no longer consider this a funny story, but the statement of a psychological study. They feel that either Mr. Davis or Mrs. Davis, or perhaps both of his parents, presented Donald with a dull intellect, that the successive teachers were all at fault because, although they vaguely recognized Donald's limitations, they failed to present to him subject matter that he could grasp in the form that he could understand.

But the complaints of the teachers about the pupils have become increasingly louder, and since there is seldom smoke without some fire, let us examine the fire of facts. The high school population of 1943 bears little resemblance to its ancestor, the high school population of 1900. It has become more than 12 times as great, increasing from 500,000 in 1900 to 6,400,000 in 1940. This increase is due to a variety of factors: public opinion favors graduation from high school, technological and social changes prevent early employment of youth, and also the age of compulsory school attendance has been raised.

This increase in numbers has resulted in a change in type of pupils. Formerly they came chiefly from one stratum of society and were preparing for college and the professions. Now they include practically all youth of high school age, recruited from all strata of society and preparing for all occupations including the industries, trades, and business.

According to Terman, 20% of the population have an I.Q. of 90 or below. In 1900 these children of low I. Q. usually left school early; now that everyone is attending high school, they are with us. This means that the complaining pedagogues are right; the pupils have gradually been becoming duller and duller. These slow pupils with I. Q.'s from 70 to 90, characterized by Terman as Dull-Normal, are now regularly enrolled in all of our grades.

What are the characteristics of these slow pupils? How do they differ from the average or bright child? How may they be identified? What and how shall we teach them?

We often feel that their mathematical attainments are similar to those of the old man in the limerick which you may know:

> There was an old man who said "Gee
> I can't multiply 7 by 3!
> Though 14 seems plenty
> It might come to 20—
> I haven't the slightest idee!"

How to pick the dull-normal from the feeble-minded or from the bright was formerly a baffling task. It was once thought that facial expression was an index of intelligence, but seasoned teachers know that this is not true. They have all had too many experiences similar to mine in which Donald, a model for Apollo, was justly enrolled in my slow ninth grade class while Bernhard, who looked like the original for any of Shakespeare's fools, was able to explain to the trigonometry class little known scientific illustrations of the principles we were studying.

It has been found that the best single instrument that can be used for identifying Donald the Dull is the intelligence test. To Binet and his colleagues belong the credit for devising this scientific tool for measuring quantity of intelligence. By patient experiment these psychologists found that average children of the different ages can answer, and their intelligence scales are series of such questions suited to the various ages. Binet's pioneering work has clarified many mental differences between the dull, the bright, and the feeble-minded and has proved that these differences are very real.

Having separated Donald and his kind from their more highly gifted class-mates, we may more easily study their common characteristics. We find that the slow children are not mentally able to make satisfactory school progress under the usual conditions. They find memories are defective, their powers of association are low, they do not see relationships easily, they have little power to transfer training, they find reasoning in all forms extremely difficult, they are self-centered and lacking in social intelligence.

Of course, dull children vary among themselves, but although they include athletes in their ranks, you have noticed that it is Donald who is constantly absent from school, either because he is ill or because somebody in the Davis family is sick. Studies by scientists prove that your observations are correct, backward children do have more illnesses and more physical defects than the average child.

Emotionally, dull children are often unstable. Cyril Burt, the noted English psychologist, compared the emotions of a control group with a backward group. He found the backward group twice as excitable, yet nearly twice as repressed and more than twice as lethargic; the backward children had twice as many anxiety states, three times as much neuresthenia and hysteria, and slightly more minor neurotic symptoms. But, to this dark picture he added this challenging comment, "It is amazing to see what a patient teacher, who is prepared to make full allowance for such temperamental creatures and to plan his syllabus along appropriate lines, can extract from this unpromising material."

"It's too bad about poor Donald Davis," the kind-hearted gossips chatter. "We all know he is dumb, but did you ever notice what beautiful hand work he does?" Until science steps in, the opinion of gossip is the opinion of everybody, except perhaps the

observing teacher. Psychologists tell us that the quality of Donald's work with his hands is comparable to the quality of the work with his mind. They say: "It is repeatedly alleged that the child that is backward in the formal school subjects will shine and even surpass his school fellows in manual subjects. The results show plainly that such generalizations are inaccurately stated. Here, as in the tests of the academic subjects, the backward still occupy a place that is roughly midway between the normal and the defective. The backward child seems good at handwork only in contrast with his own poor performance in reading, spelling, and arithmetic not in comparison with the handwork of the normal."

Perhaps you have noticed how often your Donald comes from a poverty stricken home? Frequently the Donalds are the boys for whom you are trying to find shoes, clothes, or free milk. A glance at Donald's home shows that the Davises are most often found in the lower economic strata.

Now that we have picked Donald out from his fellow-students, know something of his characteristics and home life, what shall we do with him when he comes to high school?

Mrs. Davis and Mrs. Jones were discussing such school problems at a P.T.A. meeting. Mrs. Jones said, "Have you seen the new stadium? It is wonderful."

Mrs. Davis replied. "Isn't it? Now they are building a new curriculum too."

Asked Mrs. Jones, "And what's that like?"

Mrs. Davis explained, "More like a merry-go-round, from what I hear."

If no new curriculum is built for Donald Davis and his brothers and sisters with their abilities, desires and preparations so different from the abilities, desires and preparation of the traditional high school pupil, the results to all secondary education are serious. Frequently standards are lowered to the level of ability of the slow or average pupil, which stifles the initiative of the gifted pupil, the natural leader of the next generation, and deprives him of opportunities for development. The teacher, of necessity, concentrates on helping the slow students attain these low standards. Many slow students, unable to master the work, dislike it and develop not only an inferiority complex but a hatred of school. Meanwhile the excellent students are often suffering from lack of attention since the teacher does not have time to present subject matter difficult enough to challenge their ability.

Aware of their responsibilities, some schools have wisely made curricular changes attempting to adapt the school to the new population. Courses for students entering college have been retained, but new courses have been devised to fit the abilities and the present and future needs of students who will soon be housewives or working on the farm, in industry, at trades, in business.

Administrative as well as curricular changes have been made in adapting the school to the new population. Differentiated assignments, the opportunity room for various types of pupils, homogeneous grouping, varying rate of speed and subject matter within a single class, are all devices that help in solving the problem of fitting the study to the student.

In the differentiated assignment, all pupils study the same topic in one class under the same teacher. The assignments are adapted to the ability of the students, standards to be met for attaining different marks differ in the amount of material to be mastered and in the type of effort required. Advantages of this method are that it gives Donald time to acquire the minimum essentials for which he receives a passing grade, it offers to the bright student the challenge of more difficult work, it may be used in small schools where only one section of a subject is possible, and in large schools it is very easy to administer. Limitations of the differentiated assignment method are that identical topics must be studied by all types of students,

the work differing only in degree of difficulty, which does not take care of extreme differences in ability, in preparation, and in types of training desired; the teacher may have to spend the majority of her time with the slower students; it is often difficult to make assignments so that they differentiate as to quality and not merely quantity of work; and the bright students in a class overshadow the slow students frequently causing in them an inferiority complex.

In the opportunity room one teacher is in charge of a small group each of whom is doing individual work. The pupils are assigned to the opportunity room by teachers of regular classes for short periods of remedial work. Such treatment is especially useful for pupils who have been absent, for transfers from other schools having different courses of study, and for pupils with especial disabilities. It has the added advantages that one room with one teacher may serve several grades and several subjects; it often prevents failure by giving the average or good pupil an opportunity to make up work missed while absent; and in individual work, the teacher can more accurately diagnose difficulties and provide remedial treatment. The opportunity room, requiring the services of a teacher for only a few pupils, is expensive. It is better adapted to remedial work than to presenting new subject matter to the slow student, and the pupils do not receive the benefits of a class recitation.

Homogeneous grouping provides for two or three sections of pupils in the same subject, the divisions being based upon ability as shown in intelligence tests, attainment tests, and teachers' judgments. Differentiated subject matter is taught by different methods to the different sections. Since in homogeneous grouping it is possible to adapt the subject matter and methods to suit the mentality and needs of the different sections, the teacher can devote time to developing to their greatest extent the abilities of the bright students as well as the slow students. Segregation, wisely administered, gives to the slow student a chance to excel in his own group which is excellent for his mental health.

In spite of the great opportunities it offers, homogeneous grouping cannot be used in small schools having only one section of a subject, and in large schools administrators find it difficult to build programs with different types of sections in the same subject. Also, there have not been enough studies to determine exactly what subject matter is adaptable to varying degrees of mentality or exactly what mathematics is required for the business of being a useful citizen, or housewife, for the many varied occupations of modern life.

When homogeneous grouping is impossible, some wise teachers have gained the advantages of this method by forming two or three homogeneous groups within a single class. Each group has its own subject matter, probably different from the other groups, uses its own text, progresses at its own rate of speed. This plan requires a master teacher, resourceful and a good organizer, but the excellence of the results justifies the effort expended.

Not so long ago I was haughty in my attitude as to who should take mathematics; I felt that the subject was difficult and the meat of the bright pupils. If a pupil had intellect enough to master it, I felt he would profit by choosing mathematics, otherwise, let him elect something else. More recently I have learned there is no other easier subject for him to take; if he is slow in one, he is slow in all, that a certain minimum of mathematical skill and knowledge is necessary for even the most mediocre success in the world, and that it was my responsibility as a teacher to find out how much he could learn and how he could learn it most easily.

We have learned that it is necessary to begin building on the facts the children actually *do* know instead of what they *should* know. Formerly pupils were kept in various grades until they passed certain requirements, but administrators now feel

that the social well-being of children demands that they pass to the next grade with attainment of age rather than attainment of subject matter. For this reason a teacher meeting a new class in ninth grade mathematics can not assume that the pupils have passed the eighth grade or the fifth grade standards, merely that they have passed a certain birthday.

Finding exactly what mathematical material can be taught slow children is a fertile field for experimentation and study. But we already have found out some definite facts.

Much arithmetic lies beyond the ability of the backward children. They can learn to do simple computation accurately, and also exercises which are exact illustrations of certain simple definite rules they have memorized. Problems with more than two steps they find difficult. Story problems can be solved if they are very simple and their difficulties gradually introduced.

Perhaps you have heard the story of a father who asked his son what algebra was.

Son replied: "Algebra? That's a striped horse they keep in the zoo."

This, of course, is the popular opinion of the amount of algebra the slow boy can master; but, surprisingly, this is not true. He can be taught literal numbers, substitution in simple formulas, solving easy equations, and making various kinds of graphs. Of course the work must be thoroughly motivated and very concrete.

In geometry he can at least make simple constructions; recognize and enjoy geometric forms in nature, and architecture; do considerable work with mensuration; and make scale drawings.

But given a correct selection of pupils, the best of administrative set-ups, and well chosen subject matter, the most important factor remains, the selection of an appropriate teacher. Since it is not possible to make erudite scholars from the slow of learning, the fact that they may be made into useful citizens was formerly frequently disregarded, and slow classes were often given to the least successful, or the least experienced, or to the most defenseless teachers because the whole procedure was considered a case of marking time. A better understanding of the problem has changed this practice to assigning slow classes to the most skillful of the teaching staff. It has been found that the average or bright pupils can profit somewhat even with mediocre teaching, although the best teaching is always highly desirable; but the slow students not only make very little progress with mediocre teaching but they often develop very bad habits of behavior.

The ideal teacher of slow pupils must be an excellent psychologist with a deep love for the human race, and especially for the young of the species. She must be keenly sympathetic. She must not only comprehend the limitations of her pupils, but she must realize that they do have possibilities of achievement, that while she works with a coarse clay from which it is impossible to fashion delicate and rare china, still she can save this clay from being discarded; and by exercising great skill she can mould pottery, simple but useful.

She must have infinite patience, and, along with patience, imagination so that she can present a topic not once, in one fashion (as the novice understands teaching) but many times and from fifty different points of view, if necessary, hoping that the repetition and the varying methods of approach may finally result in learning.

But with all these virtues and the added virtue of enthusiasm, she must be an excellent disciplinarian. One of my gay friends used to say, "If we can't be famous, let us be notorious." Some of the duller students appear to have that philosophy, and since they are unable to attract attention through superior attainments they try to gain the public eye by unusual conduct with the result that a large majority of the so-called bad boys are the exhibiting dull boys. Our ideal teacher must have not only *firmness* but *tact* to make simple tasks

so enticing that these difficult pupils may get their thrill from worthy achievement.

Having now acquired a correct grouping of children, the ideal teacher, and well selected subject matter, we ask how may the teacher proceed to impart to the children this subject matter effectively.

It has been found that slow pupils profit most by repetition. Bright children may make their own discoveries, but slow children need to be told.

The topic to be studied must be broken up into very small units, and one unit only presented at a time. Brighter minds grasp several facts at once; brighter minds who have been over material many times, think by grouping these small bundles of facts into still larger units. It is difficult for the teacher who is accustomed to these larger units of thought to discover the tiny steps by which the slow minds must travel. But she must discover all the steps, and (since transfer is slight in slower minds) she must present all these steps in sequence and in an attractive manner.

She must forget her expensive, college-acquired vocabulary and talk in the every-day language of the children she teaches.

If the teacher can manage to inculcate into the minds of the pupils each day that they are embarking upon a thrilling adventure, her battle is half won. One method of giving this thrill is to dramatize the lesson whenever possible. Problems featuring acts of individual members of the class are far more easily solved than the impersonal exercises of the text.

Reading difficulties form a paramount weakness to be strengthened, so oral reading with free discussion of meaning, the reading given in the form of a play whenever possible, has excellent possibilities. Since in this reading children often omit words they don't know or find difficult (which are frequently *Keywords*), especial attention should be given to vocabulary. General words as well as mathematical terms should be explained and discussed until their use is thoroughly mastered.

The span of attention of the slow child is very short, which makes it essential that there should be variety within one class period.

Abstractions are for bright children; beyond the simplest abstract ideas the slow learners can give only lip service. But concrete ideas are possible for slow learners to comprehend, so the class room for the slow children should be full of *things* through which mathematics may be taught. A 10¢ store set of measuring cups, a scale for weighing (borrowed if necessary), plenty of rulers, yardsticks, tape, protractors, a transit, squared paper, advertisements from the local papers or magazines, an old gas meter, blank business forms, Ripley's Believe It or Not—dozens of things collected by the pupils as well as the teacher—help make the subject living, concrete, human, desirable.

Although the bright boy finds drill monotonous, an unpleasant form of drudgery, Donald usually enjoys it. He is not restless if there is much repetition, and if that repetition means he has gained some power that he himself can recognize, he gains a real thrill. Much more learning can be accomplished by working a large number of simple problems than by working a small number of harder ones. Care must be taken by the teacher to see that Donald and his sister are not drilled to make habits of errors but of correct responses because they are quite uncritical of their own work and sorely need the teacher's guidance. This individual attention of teacher to pupil is of great importance and is possible only with relatively small classes.

Reviews should be frequent. Donald's memory is faulty, and should be aided by simple but thorough reviews with reteaching if necessary.

In generations past liberal use was made of the value of an emotional state in learning. In my own early teaching one of my confreres constantly boasted that she whipped the multiplication tables into her pupils. We pride ourselves upon being more humane, but we often make work

unnecessarily hard for our pupils by substituting indifference for emotion.

One of our most powerful aids in arousing emotion is *praise*. Who knows the power of praise better than the politician? Most of their lives slow pupils have been blamed, criticized, and even jeered; to hear praise of their accomplishments is strong meat for them. They are pitifully grateful for individual attention and are transformed into giants by praise. If the work is made simple enough and repeated frequently, if they are not hurried, they can gain a mastery of the subject that is worthy of praise. Honestly administered and freely used, praise arouses in the slow pupils an almost new feeling of self respect and goads them into making fresh efforts to conquer the heretofore impossible.

Is not teaching Donald and the other Davises a great adventure, often through uncharted seas? The prizes that we wish to capture for our crew of precious, if dull, human beings are self respect, confidence in their own abilities, good habits of work, a correct attitude and happiness in school, and a little accurate and reliable mathematical skill and knowledge necessary for their adult lives.

THE WORLD OF BOOKS
IS THE MOST REMARKABLE CREATION OF MAN
NOTHING ELSE THAT HE BUILDS EVER LASTS
MONUMENTS FALL
NATIONS PERISH
CIVILIZATIONS GROW OLD AND DIE OUT
AND AFTER AN ERA OF DARKNESS
NEW RACES BUILD OTHERS
BUT IN THE WORLD OF BOOKS ARE VOLUMES
THAT HAVE SEEN THIS HAPPEN AGAIN AND AGAIN
AND YET LIVE ON
STILL YOUNG
STILL AS FRESH AS THE DAY THEY WERE WRITTEN
STILL TELLING MEN'S HEARTS
OF THE HEARTS OF MEN CENTURIES DEAD

* * *

CLARENCE DAY

The In-Service Training of Mathematics Teachers

By NANETTE R. BLACKISTON
Supervisor of Mathematics, Baltimore, Md.

WM. LYON PHELPS has said, "I love to teach as a painter loves to paint—as a singer loves to sing, as a strong man rejoices to run a race. Teaching is an art—an art so great and so difficult to master that a man or a woman can spend a long life at it, without realizing much more than his limitations and mistakes, and his distance from the ideal."

As I meet with various groups of teachers, I frequently wonder how many could repeat those words and mean them as sincerely as the author did. Perhaps the number would be great, but I rather suspect that it would be small.

Why is this? Most of us start our work as teachers fresh out of college. We have spent time and money preparing ourselves, we have great faith in the profession that we have chosen and we *want* to be the *finest* teachers. Somehow, after several years spent in the classroom, some of us lose interest in what we are doing—we become disillusioned—we may even begin to crystallize. That isn't at all impossible. It has been said that there are several reasons for this. First, we are working with immature minds and that fact alone isn't challenging to us. Second, the school in which we have been placed may be so perfectly organized that we have a delightful existence free from care and, as a result, we have little reason to change. Third, we serve for several years doing the same thing repeatedly and that alone would be likely to cause us to get into a rut.

What then does an in-service training program have to do with all of this? In-service training, according to those who have written about it, provides opportunities for improving the professional performance of every member of the department. However adequate any pre-service training may have been, it is very necessary that suitable training be continued after the individual is assigned to a particular position. The ultimate aim of in-service training then according to these authors is the improvement of classroom teaching.

In addition to this, however, I believe that an in-service training program to be of greatest worth must not only provide for the improvement of classroom instruction, but must also provide for the improvement of the spirit in which that instruction is given. It must provide for keeping teachers actively interested in what they are doing and for enabling all members of the teaching force experienced as well as inexperienced to say with sincerity, *I Love to Teach.*

I hope to present for your consideration an in-service training program which is attempting to do just that thing. Because of limited time, I will call to your attention only those features of the program which seem to be of greatest help in attaining that purpose.

The first phase of in-service training that I am going to mention is the personal conference or the individual work done with each teacher. This presents, perhaps, our greatest opportunity. Only recently, Dr. Thomas Briggs in addressing a group of Baltimore administrators listed four types of supervision: corrective, preventive, constructive and creative. He had greatest faith in constructive and creative supervision because both of these emphasize strengths and build on those strengths. It is like keeping in mind the second half of the familiar quotation, "There is so much good in the worst of us," and then putting it to practice. Placing emphasis on this will improve the spirit as well as the techniques.

In my own experience I have visited the classroom of a beginning teacher who

seemed to have no ability in disciplining a class, who apparently lacked judgment in handling a lesson plan, and yet who, for just a few minutes of the period, showed signs of originality and even of creative ability in the method which he selected to present a new bit of subject matter. With that spark as a beginning, in the conference which followed the visit some of the constructive work in supervision was possible, and a young teacher who had lost heart could in time say, as he had hoped to be able to say, *I Love to Teach.*

The second aid to in-service training is committee work. You may be saying to yourselves—"But teachers don't want to bother with work of this kind." "It proves to be mere drudgery as far as they are concerned." "They do it because they have to." Perhaps again, training in techniques is being emphasized to the neglect of the training in spirit. I am proud of the committees which have been at work in Baltimore and of the contributions which they have made. There are certain features of their work which I should like to mention. One of them is the fact that, in the majority of instances, the problems on which the committees work have been suggested by the teachers themselves. They are practical problems and because the teachers feel a need for the material, they are more than willing to meet as a group to plan it. In the last ten years, committee work has included the following: suggestions for teaching the units in the course of study, sample tests on certain units of work, a sourcebook of background material for the teachers, daily drill exercises to be used in algebra classes, and practice exercises planned to supplement the work of the textbooks.

The committee appointed to work on practice exercises is always a favorite one The best material submitted by it is mimeographed at the central office and sets containing a sufficient number of copies for a class are supplied to all teachers in the department who are teaching that particular work at the time. The following are among some of the most popular exercises of this type:

1. Mimeographed sheets on which angles of various sizes have been drawn so that pupils can have practice in measuring them. There are three of these. On the first, the arms of the angle meet the scale of the protractor—on the second they are shorter and do not meet the scale of the protractor—on the third the angles to be measured are adjacent or are found in various plane figures.

2. Percentage exercises which are planned so that they follow the order in which the ideas in percentage are presented in the course of study. Since we advocate "spaced learning" rather than "bunched learning" these exercises are extremely helpful.

3. Exercises in which a comparison of common and decimal fractions is made and in which practice is provided in working with mixed numbers and mixed decimals.

4. Exercises on taxation—one of these exercises contains general information about taxation that can be used as a supervised study lesson—another exercise has for its purpose a study of the Baltimore tax bill. (This is used with a copy of the current property tax bill in the pupil's hands.)

5. Exercises on finding perimeters, areas, and volumes of the plane and solid figures, and so forth.

The chairman of the committee is, whenever possible, the individual who suggested the problem on which the committee is to work. The members are those who have shown interest in it or who have given evidence that they have valuable contributions to make. The committees are small, so that the members are able to become better acquainted with each other, and on each of these committees proper balance between experienced and inexperienced teachers is attempted. Less experienced teachers often have refreshing ideas and new points of view which prove excellent when adapted for classroom use by those who have the benefit of a greater

number of years of experience. In the majority of instances, members serve for one year and are relieved of duty the following year, so that the same few are not overburdened.

Demonstration lessons are a third important features of the in-service training program. We have always considered them valuable and formerly planned several for the department during the year. This year, however, in order to comply with a request on the part of the teachers for a greater number, the Department of Education offered a two year series of thirty lessons, fifteen to be given each year. Enrollment was optional, but those who complete the full two year series will receive office credit for a thirty-hour course. The lessons run for a regular forty minute period from 3:30 to 4:10 p.m. and are followed by a twenty minute discussion.

So far, seven lessons have been given. They have been chosen with several purposes in mind: to give teachers a picture of a cross section of the course of study; to suggest to them effective methods of handling difficult parts of the work; to emphasize preferred ways of presenting the subject matter; to enable them to discuss the place of certain units in the revised course of study and as a result of this discussion, to have them realize why changes have been made; in short, to give each member of the group something that he can use, and, through this, to give him also a new pleasure in teaching familiar material.

Up to the present time no one teacher has been selected as the demonstrator, but instead, a different teacher has been used for each lesson with the idea that each member of the department has some contribution to make to the work of the group.

The first lesson in the series was a review lesson in percentage given to a superior seventh grade group by a teacher who was especially clever in planning visual aids and in using teaching devices which made the review a "new-view" for the pupils. The second, was a lesson on the budget in which very slow eighth grade pupils used previous information from their seventh grade work to make circle graphs that illustrated interesting facts about a new eighth grade unit. The teacher had served as chairman of one of the committees and in this lesson she was able to show how effectively some of the material planned by the committee could be used in presenting the work.

The third lesson was on the line concept. Here the teacher demonstrated with a very slow seventh grade group a clever method that could be used in introducing a concept and gave the pupils an opportunity to exercise spatial imagination. So enthusiastic were they that the following day one member of the class (I.Q. 85) gave her this paragraph.

"Some people think lines look unusual. Well, maybe we do, but we think human beings are also unusual. We don't have the two dimensions thickness and width. All we have is length. Human beings have length, width and thickness. We invite you to visit Lineland sometime."

For the fourth lesson a seventh grade teacher introduced her group of average pupils to the metric system of measure. Opportunity was also provided at the beginning of this period for the teacher by means of the daily drill exercise, to demonstrate a device which we are using to give pupils greater facility in handling the units of the English system of measure.

The fifth lesson was with a slow ninth grade class. It demonstrated a way in which drawing the graph of an equation could be introduced. Much interest on the part of the observers was aroused and several viewpoints concerning the handling of the material were expressed; all of which showed that the observers were actively alert and willing to express their opinions and challenge a method if they wished to do so.

The sixth lesson was an answer to a request on the part of many members in the group—a request for the first lesson in problem solving (in algebra) with an average

eighth grade class. The teacher used a very successful method to show pupils the need for formal steps in problem solving and then obtained those steps from suggestions which the pupils themselves made.

The seventh lesson showed how, with the general method for factoring a quadratic trinomial and for finding the product of two binomials as a background, the special cases of factoring the difference between the squares of two numbers and finding the product of the sum and difference of two numbers could be presented at one time to a good ninth grade algebra class. At the end of the period, the teacher used the geometric representation of these ideas to present the complete picture in a very convincing way.

So far, the evidence points to the fact that real in-service training has resulted from the series of demonstrations. When teachers try out with their own classes lessons which they felt were especially helpful and are pleased with the results, when those asked to demonstrate are willing because they feel that perhaps they *do* have a contribution to make, when the observers raise questions, make comments, and offer suggestions during the critique following the lesson and when no group agrees that any one of the seven lessons was far superior to any other, but that each had its contribution to make, the value of such training is evident. These lessons have encouraged open-mindedness on the part of the teachers, they have shown that these teachers are willing to exchange ideas with others in the department, and they have served to stimulate teachers of superior ability because we find them interested in trying out for their own purposes, points about which a discussion has arisen.

There are other phases of in-service training: departmental meetings within a school, inter-visitation of teachers—both visits made by beginning teachers to more experienced ones and visits of experienced teachers to others who are equally experienced, and so forth, but I shall mention in detail only one more and that is the opportunity for in-service training that is afforded by having, as visiting speakers, leaders who have kept interest in mathematics alive and who have shown that they themselves are examples of the teacher who loves to teach.

We have attempted whenever possible to arrange for the teachers not only to hear these speakers, but also to meet them in an informal way—at a group conference, or a banquet, or even better, at a dinner in front of an open fireplace on a cold night. In this way the spirit and the personality of the speaker serve to stimulate the teacher—she feels that she has had the rare privilege of meeting a truly inspiring person. She has talked for awhile in a very informal way to the man who has written the textbook that she is using with her classes, or to the one who has written an article that she has read or a book that she has studied. And enthusiasm is contagious, so contagious, in fact, that after such experiences the teacher goes back to the classroom with renewed energy and determination to see that the pupils in turn share some of the enthusiasm that she has received.

This then is the in-service training program that I wanted to present to you for your consideration—the program which has for its major objective the training of teachers who always will be able to say, and to mean it sincerely when they do say it, *I Love to Teach.*

Mortar for the House of Algebra

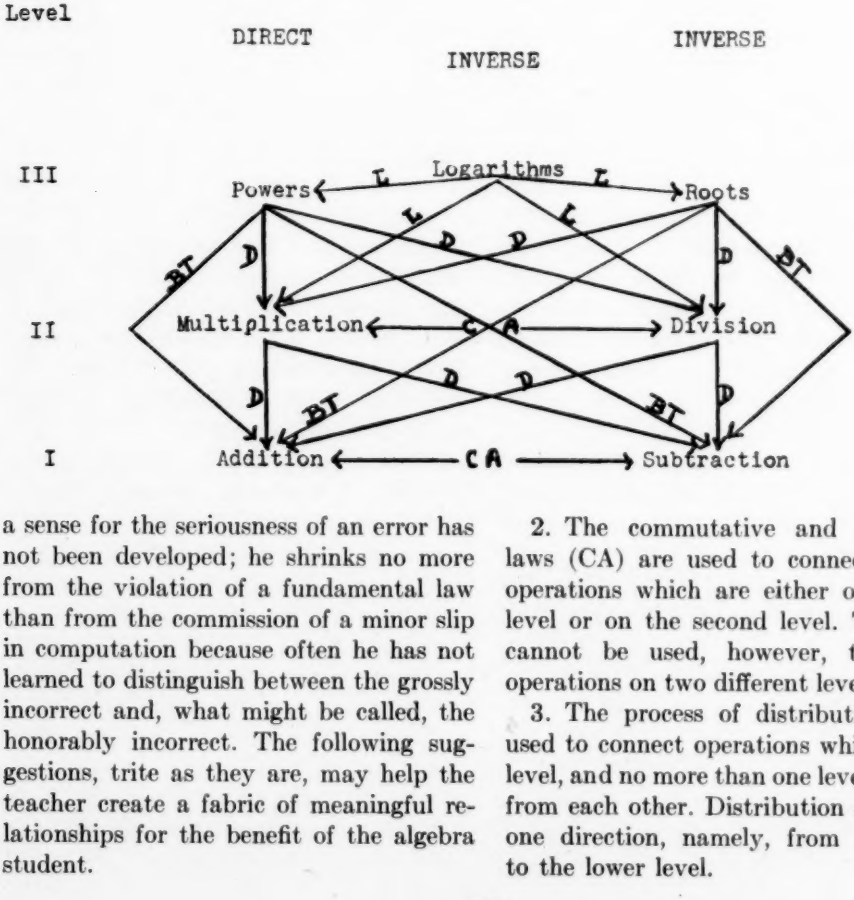
By PAUL R. NEUREITER
State Teachers College, Geneseo, New York

THIS IS a plea for more generalization, more system, and greater emphasis on interrelationship in the teaching of high school algebra. The student who continues his mathematics work in college is often found quite proficient in the purely manipulative aspects of algebra, but he rarely has any conception of the laws and broad relationships which compose the theoretical substructure of elementary algebra. Hence it is not uncommon for the college teacher to see a skillful operator in algebra suddenly committing a mathematical atrocity with the blithe air born of innocence. Even in the successful student a sense for the seriousness of an error has not been developed; he shrinks no more from the violation of a fundamental law than from the commission of a minor slip in computation because often he has not learned to distinguish between the grossly incorrect and, what might be called, the honorably incorrect. The following suggestions, trite as they are, may help the teacher create a fabric of meaningful relationships for the benefit of the algebra student.

There are certain characteristic dichotomies which determine the pattern of secondary school algebra. There is, first, the cleavage between the direct and inverse operations; second, there is the distinction between different levels of operation. The following schematic outline may well be kept before the student's eye while he is taking a course in algebra.

The common operational rules are easily fitted into this plan.

1. If there are no parentheses in an algebraic expression, the operations of the higher level are performed before those of the lower level.



2. The commutative and associative laws (CA) are used to connect the two operations which are either on the first level or on the second level. These laws cannot be used, however, to connect operations on two different levels.

3. The process of distribution (D) is used to connect operations which are one level, and no more than one level, removed from each other. Distribution operates in one direction, namely, from the higher to the lower level.

4. The binomial theorem (BT) is used to connect operations of the third level with those of the first.

5. Logarithms lower (L) the level of operation because the laws of exponents involve the descent from an operation to the corresponding one on the next lower level. The usefulness of logarithms in computation is thus established; since no descent is possible from the first level, it is at least plausible that an addition or subtraction provides a stumbling block to logarithmic computation.

The third level is not subject to the commutative law; and it is for this reason that involution permits of two kinds of inversion while addition and multiplication appear to have only one. To be precise one should say that every addition or multiplication of two numbers can be inverted in two ways, but that the two ways yield the same operation because the commutative law applies. The same does not hold true on the level of evolution.

Among the laws to be violated the distributive seems to be a favorite. This is especially true when the beginner deals with fractions. The symbolism of fractions is singular in that it combines a direct with an inverse operation, the numerator implying multiplication, the denominator division. A fraction represents, therefore, a tug of war between opposing forces. If both are strengthened or weakened equally (the mathematical interpretation of the word "equally" in this context making a subtle subject for investigation), there should be no net effect on the value of the fraction because the changes made in the terms are mutually compensatory. What the student is likely to overlook is the obligation of making these changes solely on the level on which fractions, by their very nature, operate. As soon as another level is brought into the situation, for example, by the addition of like quantities to both terms, the problem assumes a distributive aspect, and the value of the fraction changes. That the distributive law operates only in one direction is also easily forgotten. While $(a+b)/c=a/b+a/c$, the fraction $a/(b+c)$ cannot be decomposed so simply because the divisor distributes itself between the addends of the dividend, but the addends of the divisor do not distribute themselves with respect to the dividend. The direction is solely from division to addition.

We compare numbers by any one of the three inverse operations. "John is three years older than George," indicates comparison by subtraction. "John claims to be three times as strong as George," means comparison by ratio, i.e. division. Harlow Shapley asserts[1] that man is in a middle position between the unit electron and the biggest star because "giant stars contain about 10^{58} corpuscles (electrons and protons)" while "an average man's body contains 10^{29} corpuscles—halfway down towards the unit electron." Here exponents, or logarithms to the base 10, are used to establish the comparison.

The comparison of members is related to the idea of growth. There may be growth by equal added increments as in the terms of the arithmetic progression, or growth in the sense of multiplication as in the geometric progression. Accordingly, the formulas for the last terms are analogous, $l=ar^{n-1}$ and $l=a+(n-1)d$, the former operating on levels which are one step higher than those of the latter. If the growth of numbers is symbolized in functional notation, growth by equal added increments results in a linear function whereas growth on the higher levels may produce an exponential type. The contrast between two levels presents itself again in the difference between arithmetic and geometric means. The recognition that approximate values of logarithms can be calculated by the comparison of an arithmetic with a geometric progression fits into this web of concepts.

The ideas of commutation, association and distribution can best be taught through arithmetical examples; and since

[1] Harlow Shapley: *Flights From Chaos.* New York: McGraw-Hill Book Co., 1930.

there is no public law against the mentioning of arithmetic in algebra classes (although many teachers act as if there were), it might very well be pointed out that the three direct operations are employed and implied in the Hindu-Arabic system of notation, which represents a number as a polynomial in the radix 10. There is another aspect to the three-storied structure of the operations which helps create insight. The operations on the higher levels grow out of the lower ones by a process of restriction to selected numbers. Multiplication is the addition of like numbers, involution the multiplication of like numbers. One could raise the question whether the student encounters procedures for the simplified addition of unlike numbers. Indeed, he does in the sum formulas for the progressions; but here, too, there is a definite pattern according to which the numbers change; otherwise no formula would be available.

To the teacher with philosophic inclinations the matter of inversion should provide a real feast. Here he has occasion to present what is undoubtedly one of the profound and universal features of the creation: the doing and the undoing, thesis and antithesis, anabolism and catabolism, to mention some analogies; the possibility of traveling over the same road in opposite directions, with the conceded qualification that this is only feasible in the somewhat idealized world of mathematics, while the sum total of physical happenings is irreversible, the Second Law of Thermodynamics ruling supreme, and in the moral realm, too, a deed can never be fully undone. Mathematical inversion, as demonstrated in algebra, has features in common with such diverse things as a round trip ticket, the historical cycles of revolution and counterrevolution, the mutual annihilation of opposites, evident in electricity, the proverbial Kilkenny cats, the rules for signed numbers. And what should be easier, the building up or the tearing down? Here the student is likely to gloat at your discomfiture; for, whereas it is easier to demolish a building than to construct it, he knows from experience that the inverse operation usually offers greater difficulty than the direct one. But just a moment. Is it not often more difficult to untie a knot than to tie it, and who has ever unscrambled an egg? The point is that in mathematics we never demolish, we disassemble like precision mechanics, every part remaining intact; and if you had to do that in tearing down a building, you would much prefer the job of construction. So the inverse operations are more likely to land us in trouble, as every grade school youngster will testify. In order to permit their unrestricted performance we even have to extend our number system from natural to fractional, negative, irrational, and imaginary numbers. Inversion should also help clarify the mystic rules of transposition invoked for the solution of equations. Asking a question in the language of symbols, the equation offers the unknown in a tangle with certain known quantities. The tangle is made by certain operations, and the corresponding inverse operations are called into service to undo it. A student who understands this point is not likely to dispose of a factor by subtraction.

The plea made here springs from the experience of teaching college freshmen who have been good students in good mathematics courses taught in good high schools. In many respects they seem well prepared for further work in mathematics; in almost all cases they are found ignorant of the basic principles which unify and simplify algebra and also lay the foundation for much of higher mathematics. The suggestion that there should be more deductive reasoning in algebra courses, so as to cement the various concepts and processes into a logical whole, would seem justified.

Developing Mental Perspective and Unity of Principle in Geometry

By PETER DROHAN
Brudenell, Ontario, Canada

IN GEOMETRY almost every figure has a manifold of symmetric relations connected with it. The grouping of these associated properties may be made a valuable aid not only in systematizing fundamental principles but also in emphasizing what might be called the aesthetic element in spatial analysis. A new perspective, too, is thus given to a student's geometrical knowledge, and a vastly increased cultural value added to it.

Take, for example, the triangle in elementary plane geometry. What a wealth of beautiful and interesting relations may be grouped about this simple figure—the first possibility of enclosing a space by straight lines! In what follows we shall try to show it as a symmetrical unit containing within it a multiplicity and variety of interrelated symmetries that deserve to be designated the logic and poetry of space—ideal images of reality according to Plato, unfolding as a rhythmic order, evidencing the aesthetic as an innate characteristic of the cosmos.

At the outset the triangle is a unique figure, three points determining three lines and vice versa. Points, lines, circles, pencils, and even the more general conics are connected with it in a remarkable and fascinating way. First, the reciprocality of concurrent lines and collinear points is striking. Again, the number of identities involving the squares and rectangles on lines connected with the triangle illustrates many beautiful examples of symmetry. Finally, from the vertex of a triangle there may be caught a glimpse of the way leading to projective geometry, for, when the interior and exterior angles at a vertex are bisected, the arms of the angle and the bisectors produce an harmonic pencil which is a sign-post leading to the wonderful field explored so extensively by Chasles and Poncelet. The same vertex may be considered as a point on an ellipse or an hyperbola, the opposite side the distance between the foci, the arms of the angle, the focal distances of the point, and the interior and exterior bisectors the normal and tangent to the curve respectively. Thus, connection is made with the domain of geometrical conics. Hence, although the student may have gone far afield, there are vistas reaching back to the initial steps of the study.

Now, to consider the points of concurrence and collinearity, one of the most obvious is perhaps the fact that two triangles so situated that their vertices are concurrent in pairs, have their corresponding sides intersecting on a straight line. This is, of course, the well-known theorem of Desargue. The fundamental concepts, however, of concurrence and collinearity are the theorems of Ceva and Menelaus. The former states that, *if points are taken in the three sides of a triangle such that the product of three alternate segments taken in circular order are equal to the product of the other three, and, if each vertex is joined to the point in the opposite side, the lines are concurrent.* The theorem of Menelaus posits that, *if three points are taken in the sides of a triangle, one of the sides being produced, so that the product of three alternate segments are equal to the product of the other three segments, the points in question are collinear* (it is assumed that the segments are taken in circular order). Using these relations as criteria, one can establish a great variety of interesting theorems such as: *the straight lines joining the vertices of a triangle to the points of contact of inscribed or escribed circles with the opposite sides are concurrent; tangents to the circumcircle of a triangle at the vertices meet the opposite sides in col-*

linear points; the intersection of the sides produced of any triangle with the sides produced of its pedal are collinear. A very remarkable instance of collinearity is the fact that the orthocentre, centroid, circumcentre, and the centre of the nine-point circle are on a straight line, the centroid trisecting the line and the nine-point centre bisecting it.

A line of collinearity that naturally leads to relations with the circle is the Simpson Line, or the theorem that the projections of any point of the circumcircle on the sides of the triangle are collinear. However, possibly the most wonderful relation of the triangle and circle is the concylic order of the feet of the altitudes, the feet of the medians, and the points of bisection of the lines joining the vertices to the orthocentre —the nine-point circle. To quote one more example from the numerous theorems to be found in textbooks and examination papers: *the circumscribed circle of any triangle bisects the lines joining the centre of the inscribed circle to the centres of the escribed circles.*

From circles connected with the triangle, a consideration of rectangular properties of lines related to the triangle may begin. We have the theorem: *The rectangle contained by the altitude of a triangle and the diameter of its circumcircle is equal to the rectangle contained by the sides about the angle from which the altitude is drawn.* Another case is the following: *The rectangle contained by the sides of a triangle is equal to the square on the bisector of the contained angle plus the rectangle contained by the segments formed by the intersection of the bisector with the third side.* Again, take any point in the plane and join it to the centroid of a triangle, then *the sum of the squares on the lines joining the point to the vertices of the triangle is equal to the sum of the squares on the lines joining the centroid to the vertices, plus three times the square on the line joining the point to the centroid.* In referring to the simpler metrical relations connected with a triangle, those existing among the sides are worthy of notice. Thus, *the square on the side opposite an obtuse angle is equal to the sum of the squares on the sides containing the angle together with twice the rectangle contained by either of these sides and its projection on the other side;* if the angle is acute, there is no change except that the rectangle has changed sign; if the angle is right, the rectangle disappears and the Pythagorean Theorem appears.

Mention has already been made of the triangle in relation to the conics. Wider relationships are revealed by a more extensive acquaintance with these curves. For instance, *the locus of the centres of all conics passing through the centres of the inscribed and escribed circles of a triangle is the circumscribing circle of the triangle;* or *the locus of the centre of a rectangular hyperbola which circumscribes a triangle is the nine-point circle of a triangle.* Still another example is recalled in the following: *the area of the triangle formed by three points on a parabola is twice the area of the triangle formed by the tangents at these points.* Many other relations of a similar nature might be cited but they would all tend to prove how the significance of a principle increases with the growth of knowledge, illustrating the idea that, as a conception widens, its content grows deeper.

The preceding paragraphs are merely suggestive, recalling a few of the geometrical relations that might be made to center about the triangle. The purpose is to show how a secondary school or even a college student's knowledge of geometry might be co-ordinated and unified by grouping it about certain configurations such as the triangle, quadrangle, circle, and the like. Viewing geometry in such a perspective, too, would seem to foster an admiration of spatial symmetry. Not only are the intellectual powers developed but the imagination is also stimulated by seeing relations thus grouped in more comprehensive units. Instead of mere room to move about in, space becomes a mental panorama of transcendent beauty. Truly

did the ancient sage assert that a knowledge of geometry is a passport to the study of philosophy. It is a long way from Pythagoras to Newton, but geometry served both of them; the square on the hypotenuse is remarkable but more so is the discovery of the law of inverse squares which shows the path of a material particle in a gravitational field to be a conic section.

It must not be understood, of course, that such a procedure as has been discussed could be used at the beginning of the study of geometry. Only after some progress had been made, and preferably not until the final review of the year's work, or the course, could such a plan be profitably pursued. However, to orient a student's work, both for use and for culture, such a scheme ought to be highly beneficial. It would tend to make geometry more than the tool of the engineer, the physicist, or the astronomer. It would present it as something like a structural principle of the whole cosmic edifice.

In the processes of geometry reasoning is seen at its best; in the results achieved, that is in the propositions established, there is, it would seem, a glimpse of the infinite breaking through the finite. Again, how happy it would be for man if the methods of geometry could be applied to social and economic problems. Wars might vanish, and injustice too, truth come unto its own, and the vison of a morally revitalized humanity become a reality. Although Euclid's reply to king Ptolemy is as true today as it was two thousand or more years ago, yet stressing the aesthetic element so prominent in many phases of the study, and grouping relationships in larger units could not fail to develop a mental perspective conducive to an enlargement of soul not usually associated with mathematics.

Concerning Subscriptions that Expire in May

ANY ONE who began his subscription to THE MATHEMATICS TEACHER with the October issue in 1943 is automatically a member of the National Council of Teachers of Mathematics until October, 1944. However, since no issues of the magazine are published in June, July, August and September of 1944, those who paid the membership fee of $2.00 in October of last year should send in their renewals before October, 1944 in order to save the Council inconvenience and loss of money. Costs of publication are rising and in order not to have to raise the price of the journal during the emergency we bespeak the cooperation of our members in being prompt in making renewals. In order to make sure that this matter is not overlooked, THE MATHEMATICS TEACHER will send out early in April, if not before, cards to all members whose subscriptions expire in May (even though their membership runs to October) and it is hoped that members will be prompt in renewing membership so as to facilitate matters in the office. It has been almost impossible to plan for the October issue each year because members are so careless about renewing in time. Moreover, entirely too many members fail to renew at all even though two or three notices and a personal appeal from the Editor have been sent out. It is more important now than ever before to "stick by the ship" if we are to weather the storms ahead and if the Council is to continue to do its work effectively. EDITOR

An Open Letter to Teachers of Mathematics

By A. M. Withers
Concord College, Athens, West Virginia

An important article by Professor Robert A. Hume, "Shall We Be More Practical?" *School and Society*, January 2, 1943, links together (not for the first time, to be sure) the fortunes of the pure mathematics in the high schools and colleges with those of the ancient and modern languages. We language advocates must never forget, he says in effect, that when educationists swing their cudgels at the heads of algebra and geometry, our own heads are in danger; and by the same token when they "crack down" upon the languages, algebra and geometry and all their kith and kin had better look to themselves. You have yourself no doubt noticed that the writers who belabor high-school mathematics in the lay and professional prints often couple the foreign languages with them as *participes criminis*.

In the February, 1943, issue of *Clearing House* Mr. Philip Blumberg, who has more than once attacked the modern foreign languages and the classics (for example, *School and Society*, June 27, 1942; December 26, 1942; June 26, 1943) as encumbrances in the high-school curriculum, affirms a need of severe pruning of high-school algebra and geometry. It is his article that is the immediate irritant occasioning the composition of the present letter. But I have also read from time to time in The Mathematics Teacher extremely pessimistic views on the present status of mathematics in the high schools which show this feature of education facing exactly the same sort of uninformed opposition as retards and represses the foreign languages.

My desire in this letter, I may state without waiting, is to insist with Professor Hume and others of like persuasion that languages and mathematics should be strong and close, and publicly-announced allies. When a teacher of the former urges the necessity of the languages in the high-school course of study, and the intelligent and systematic backing of them by school boards, superintendents, and principals, he should not fail to include insistence on a common-sense attitude toward the obvious foundational intellectual values of traditional high-school mathematics. And likewise those who write on mathematical discipline for high-school youth should not fail to stress also, if they feel it, their complete allegiance to the foreign-language element in the curricular scene. I make this injunction with confidence, for I am sure it will, if I may mix my metaphors, strike a responsive chord in the hearts of both our "houses."

At least two foreign-language colleagues of my acquaintance are teaching Physics in the present emergency, and the supposition seems logical that there are many more such cases, for the mathematical and the language disciplines have much in common from the intellectual point of view. I was myself at one time instructor in mathematics in the Georgia School of Technology, and observed that most of my colleagues in the department there were by no means indifferent to, or uncultivated in languages and literatures. And throughout my career as graduate student and teacher of Romance Languages I have found that the mathematics men and women are generally of a type not to be thrown into a mystic haze by an occasional word longer than the average. To make a long story short, the mathematically and the linguistically trained are (and of right ought to be) "brothers under the skin."

But to return to Mr. Blumberg, who has hurled a lance at mathematics. This writer uses the peculiarly insidious method

of citing out of context the words of well-known friends of mathematics and the foreign languages to confound all other friends of these subjects. He quotes from Will Durant (*School and Society*, June 26, 1943, p. 706) to prove out of the mouth of an avowed and conspicuous friend of the humanities the fragility of the cause of Latin and Greek; and from Abraham Flexner (*Ibid.*, p. 705, and in the *Clearing House* article), who is assuredly not a "whooper-up" for limitation of the humanities, to say the least, to bolster complaints against the extensive maintenance of either the foreign languages or of algebra and geometry. As to Dr. Flexner, it may be said with assurance that it is not these essential subjects he inveighs against, but the insufficiency of time allotted to them in our American overstocked curricula.

There are, it is true, if I may speak for a moment exclusively of the languages, a few, a very few, men of learning who seem to take a sort of pride in setting little store by their classical studies in so far as their control of a splendid English style is concerned. This is apparently the case with Will Durant, William Allan Neilson, and Winston Churchill. If these men had not had a large amount of training in ancient and modern languages in their backgrounds, and did not at the same time possess their enviable prose styles, their cavalier disregard of the need of Latin for the language health of the average man or woman might have some weight. But when one compares their highly expert facilities in choosing words and phrases with the woodenness in this regard of most of the enemies of the foreign languages, the truth shines through that the influence of that general language learning has been of mighty service, not less mighty because so unobtrusive that Neilson, Durant, and Churchill can actually doubt its profound reality. And even granting for the sake of argument that special linguistic aptitude, environment, or genius would have been sufficient to bring these men to their high competence without the aid of Latin, that could hardly be considered devastating proof of the worthlessness of Latin for English in contradiction to the testimony of hundreds and thousands of acknowledged leaders of expression in the latter language.

The Latinless individual, by which I mean one who has either had no contact with Latin, or has not had the power or patience to profit from it, frequently betrays himself when he tries to soar above the flatter commonplaces of his native speech, For example, the author of a recent article, obviously thinking he had a fine "precision fit," wrote: "What a *consummate* amount of wishful thinking!" and demonstrated further his exquisite language-immaturity with "a fine, adequate, rich, and full vocabulary." Another writer, in an Education journal editorial, said: "The questionnaire is a necessary and *imperative* instrument of education. It in certain cases permits a *fluency of effort* and a *degree of results* which could not be reached by any other approach." And again: "If it (the questionnaire) is merely the symptom of an itch it *incurs* no moral or professional obligation upon the recipients to scratch." A particularly "dynamic" professor, "sold" on all new subjects, and the desirability of change for its own sake, wrote to the teachers' agency that he had only *praiseworthy* words for my imposing stock of abilities. I include these little particulars with the thought that you will enjoy a laugh with me at the expense of our common detractors.

I should not venture to prescribe what the teachers of mathematics should do to advance their own immediate and long-range plans and purposes, but whatever their own devised remedies they cannot fail to parallel ours for the foreign languages. I should only insist that from every point of view it is in order for all of us now not alone to talk of a joining of hands, but actually to join them.

An article by Dean Roscoe Pound, of the Harvard Law School, "The Humanities in an Absolutist World," *The Classical*

Journal, October, 1943, represents the type of writing that can do the most good to our mathematics and language "houses." He sharply distinguishes there those things that are fundamental in early training from those which are not, urging for example that the Social Sciences have no right to precedence as foundational. Such subjects need to be approached, he tells us, with maturity of mind. Besides, they are not really sciences in the correct use of the word, but largely speculations on matters in flux, in no sense fair substitutions, as initial preparation for life-long learning, for the things of mathematics, history, the natural sciences, and the languages.

It is not wise nor good, of course, in pressing the values of our studies, to issue wholesale condemnation of all the changes that the last several decades have brought into our schools. But the "first things" must be clearly distinguished from the "second things" in the curriculum. The latter are not necessarily less indispensable or less important. But those "second things," confronted too soon, call for an impossible maturity, whereas the "first things" are to make maturity possible, and to accelerate its coming.

The advisability that we act together as representing those "first things," and therefore as natural allies, is not made more evident by my insistence upon it. It may be well however for us in foreign-language ranks not to delay in giving you in mathematics the hearty assurance of our understanding of your place as comrades of ours in the promotion of the fundamentals in education, an assurance which you will undoubtedly like to have just as I should like to receive a similar commitment from the side of mathematics, in writing, that is, and spread far and wide in periodicals, lay and professional.

(1) To quote from *Pre-Law Education*, a pamphlet for the information of pre-law students published (1942) by the Executive Committee of the Association of American Law Schools, p. 7:

"Foundations must be laid in high school for the study of English, foreign language, history, mathematics, and science. The pre-legal student will generally be well advised to defer philosophy and the social studies until he has entered college. If pre-legal study is planned effectively, the foundations for a broad culture may be laid during the high school period and the first two years of college."

This also, from the *Suggestions on Pre-Legal Study* (1942) of the Ohio State University, pp. 2–3, is pertinent:

"No specific courses are recommended for the development of good study habits. This is something each person must acquire for himself no matter what subjects he studies. It should be apparent, however, that the difficulty of the subject matter of a course is not an adequate reason for omitting it from a program. On the contrary it may be a good reason for including the course."

Poem

By MARGARET DETTERER, *High School Sophomore, Philadelphia, Pa.*

G is for the Geometricians who gave it its name
E for Euclid—his overlapping triangles won fame
O is for the Orthocenter, that's where the altitudes meet
M for Mathematics, without this it's not complete
E is for the enjoyment we received right from the start
T for the triangles, they play quite a main part
R is for the rank of this subject among the rest
Y for "yes" of course, it's the best
These eight little letters, now what can they be?
Of course, you know, it's
GEOMETRY

Why Mechanical Manipulation?

By William S. Tobey
Junior and Senior High Schools, Long Branch, New Jersey

Just how difficult it is to purge our thinking mechanism of early implanted misconceptions is brutally manifest in Mr. Richter's splendid and most timely article in the February issue of The Mathematics Teacher. He states that it has been found that those aspects of algebra which involve thinking are retained to a much greater degree than those involving mechanical manipulations. To Mr. Richter and to most of us, who studied our high school algebra before the days when an over indulgent public became possessed with the mistaken notion that somehow the schools could literally implant education into a neutral mind, there really are no mechanical manipulations in algebra. No mental growth occurs from a manipulation that is not in direct response to some reasoned decision. Lapses in adherence to this principle in the forms of rules, such as invert divisor, transpose, change signs, cancel, and the like, are the cancerous infestations which, during our recent prodigious experiment in the field of untrained and inadequately and inexpertly supervised teaching, have brought down upon us the present widespread and generally warranted criticism.

Who was ever taught to find the product of .08 and $\frac{1}{5}$? Who among us was not taught that we must first divide 1 by 5 to change $\frac{1}{5}$ to a decimal, being most careful to apply the rule for placing the decimal point in the correct position, and then multiply the result by .08 and apply a second rule for placing the decimal point? Many of us who have fair memories can recall numerous instances similar to this. We gazed with satisfaction at our result. A result as correct as the passing of a star and as meaningless as exact. No teacher was kind enough to let us deal with the situation naturally. Had we been left to our own devices we would have treated one fifth of eight hundredths exactly as we treated one fifth of eight bushels or one fifth of eight dollars. Some of the most clever among those who taught us would have led us to see that the problem becomes much simpler when eight hundredths is changed to eighty thousandths. Just as one fifth of eighty chickens is sixteen chickens so one fifth of eighty thousandths is sixteen thousandths. No good teacher would have suggested the easier method before exhausting the teaching and learning possibilities in the original. To obtain a result in the form of one and three fifth hundredths is not an unnatural or unusual experience for a seventh grade pupil. It differs not in the least from one and three fifths pounds or one and three fifths bushels to a pupil who has not been beguiled by the artifices of an older generation which knows no arithmetic. It is not probable that the successful businessman or the college professor who were unable to find the product of .08 and $\frac{1}{5}$ are isolated examples of the weakness in arithmetic among members of our generation. We were fed on "mechanical manipulations." The saddening aspect of the situtation is our determination to perpetuate this mental morass. We insist that very young children learn to count to one hundred before they can grasp the meaning of the first ten numbers. We have children add numbers whose sums are more than ten before they have mastered the situation in connection with real objects. To deal with symbols before becoming acquainted with the objects and processes for which these symbols stand does not make sense to the rational adult. We expect children trained by this method to understand and enjoy arithmetic. Nothing could be more absurd.

There are three steps which, if taken, will carry us far toward extracting us from the muddled mess in which we find ourselves. The first of these is a step, a deliberate and giant step, away from "mechanical manipulations." No child from the kindergarten up should be permitted to manipulate numbers in any way except by consciously utilizing some discovered law. The moment a child makes one move in the solution of a problem by following directions either in the form of written rules or presented verbally by a teacher he is headed for the situation which has proved so painful during the war period.

The second step is away from mediocrity in teaching and inexpertness in supervision. We reconcile ourselves to the necessity of placing our resources and the lives of millions in the hands of experts. It would seem logical and sensible that we entrust the training of those who are to sustain the liberties and way of life for which we struggle to equally expert men and women. When we realize that the course of civilization will be determined by the kind of thinking that people are capable of doing, and that the kind of thinking that people do is largely conditioned by the type of teaching they receive when young, we may be prepared to insist on expert teaching.

The third step is away from algebra and geometry. These subjects, as at present comprehended, are stepping stones, and good stepping stones, toward higher mathematics. They are of little value to some eighty per cent of the secondary school population. It is quite possible that their study is a definite detriment to many. College students do not find their college work difficult because of lack of training in algebra and geometry but rather because they are weak in arithmetic. Inductees find their training difficult because they do not have a mastery of the fundamentals.

It is time we shift the emphasis from diagnosis, faultfinding and remedial activities and direct it toward sound foundations through better teaching and more adequate and expert supervision.

America's Financial Problems

WILL RETURNING servicemen be asked to assume the burden of paying for the war? Why don't we pay for the whole war out of taxes? When will the danger of inflation be over? How soon after the war should war controls (price control, priorities and rationing) be relaxed? Answers to these and related war finance problems are given in *America's Financial Problems*, an address by Daniel W. Bell, Under-Secretary of the Treasury.

The Minute Man, field staff magazine of the Treasury's War Finance Division, has devoted its entire April 1st issue to the speech. Pictures, graphs, table, sub-heads, an outline for study and discussion, and a list of reference material effectively supplement the text.

This clear, comprehensive statement of war and post-war financial problems offers material of special interest to teachers of economics, social studies, current events, and history. Single copies are available free on request from the War Finance Division, Treasury Department, Washington 25, D. C.

Measuring Arithmetical Achievement[1]

By LELA G. VAN ENGEN
The University of Wyoming, Laramie, Wyoming

SOME OF THE common questions that confront the classroom teacher in regard to arithmetic are closely related to measurement and based on what should be taught. A few of the questions might be stated: How can tests be improved so that fundamental concepts, reasoning and estimation can be measured? Do people who have ability in computation also have ability in reasoning and estimation? Would arithmetic have a better carry-over into real life if the reasoning type of arithmetic were stressed?

There is a need and a place for computation, but many of the present-day methods have been concerned entirely with "facts" and "written problems." There are other outcomes in arithmetic which are just as important but are more difficult to determine and test and therefore are neglected in our teaching and evaluating of arithmetic. Our methods and also our text books in the average school are not conducive to this new method of teaching arithmetic which many of the leading educators advocate. As Thiele says, "The keynote of the new arithmetic is that it should be meaningful rather than mechanical."[2]

Brownell believes that, "Classroom instruction has emphasized the outcomes and only the outcomes with which measurement technicians and some measurement theorists have worked. The poverty of the results of arithmetic teaching under the old scheme of things has been all too well exposed."[3] Realization is even clearer when we see the struggle many adults have with life situations, which are due to lack of understanding in arithmetic. Examples of this struggle are measuring distances and weights, changing the size of recipes, or working with money.

A similar idea is expressed by Wheat. "The basic problem of instruction is the question whether to teach the subject directly to pupils or to teach pupils methods of learning the subject so they can teach it, or much of it to themselves."[4] How much of our testing is based on the child's ability to reason and portray his knowledge of the number system if it is developed by the meaningful method?

There are many different ways of testing arithmetical ability and also there are many different phases of this ability which can be tested. In order to answer some of the questions that had arisen a test was built to determine the child's ability to interpret meaningful concepts, to reason and to estimate answers. Special attention was given to the words used in the reasoning problems since vocabulary plays such a big part in the child's ability to interpret them. Even though easy vocabulary is used, the problems may not be stated clearly. This also was given extra attention so that these two factors wouldn't alter to a great extent the child's answer.

An effort was made to divide the test into three parts. The first part was based on concepts relative to counting, the number system and fundamental knowledge. Reasoning problems composed the second part, and the third part dealt entirely with estimating answers.

A Standardized Test was then used so that the outcomes of the two tests might be compared and evaluated. The Standardized Test places more emphasis upon

[1] This paper is a condensation of the author's thesis submitted for the Master's degree at the University of Iowa in July 1942.

[2] "Arithmetic in General Education." National Council of Teachers of Mathematics, *Sixteenth Yearbook*. Bureau of Publications, Teachers College, Columbia University, New York, 1941, p. 45.

[3] *Ibid.*, p. 227.

[4] *Ibid.*, p. 108.

skill in computation than reasoning and the ability to discover procedures. It has been built chiefly to test the arithmetic of the average school and therefore, is a good instrument to use in getting information on the general value of the Experimental Test.

Two hundred eighty-three children in the fourth and fifth grades of the public schools of Iowa City, Iowa, were used in this experiment. They were given both the Standardized Test and the Experimental Test. The tests were checked very carefully in order to prevent scoring errors. Tabulations for the difficulty and discriminatory power of each problem were carefully checked.

The reliability coefficients for the Experimental Test and the Standardized Test were computed by using the Pearson product-moment coefficient of correlation method. They were stepped up by using the Spearman-Brown prophecy formula. The reliability coefficient for the Experimental Test was .93 and the Standardized Test had a reliability coefficient of .94. The coefficients found in comparing the total Experimental Test scores with the scores of the problem section of the Standardized Test and the complete Experimental Test scores with the complete Standardized Test scores were .73 and .75 respectively.

The validity of a test is concerned with whether it measures what it purports to measure. It is difficult to discriminate between a valid test and one that is less valid. However, there are a few ways which aid in determining whether a test measures that which it is supposed to measure. The methods used were (1) using the questions for individual tests and class tests with a control group before putting them into the test, (2) selection of test items which other tests and teachers had considered valid, and (3) using problems that were expected to measure reasoning and estimation. The variance of the final scores shows that there is a different ability measured when the stress is laid upon reasoning than when it is on computation.

There are a few problems which arise when one is testing abilities as intangible as concepts, reasoning, and estimation. Stretch[5] found that all of her correlations showed significant positive relationships between problem solving ability and the ability in comprehension of reading. We know that the ability to read carefully plays a larger part when one correct response must be selected from four possible answers than it does if it were just a matter of subtracting, adding or multiplying.

Another problem in regard to the reasoning and estimation sections of the Experimental Test is the fact that the exact answer was not given and the child was asked to select the most nearly correct one. The ability to round numbers and estimate answers was tested in this way and rightly so because many of our everyday life problems are answered in this manner.

This study found that the correlations between reasoning and estimation and between reasoning-estimation and problem solving-computation are statistically significant. On the whole, if a child has ability in reasoning, he also has ability in computation. The intercorrelation between the problem solving and the estimation of answers was .43. Since this correlation is significant and yet much lower than the other correlations, another ability must be involved. It might be advocated that more reasoning problems should be included in our arithmetic tests since arithmetical ability can be measured by them.

[5] Stretch, Lorena B., "The Relation of Problem Solving Ability in Arithmetic to Comprehension in Reading." *Contributions to Educations*, Number 87, George Peabody College for Teachers, Nashville, Tennessee. 1931.

A Study of Weights and Measures
(Another View)

By J. T. JOHNSON
Chicago Teachers College, Chicago, Illinois

THE ARTICLE on "A Study of Weights and Measures" by Gertrude Cushing Yorke in the March issue of THE MATHEMATICS TEACHER deserves an answer as it contains statements that may mislead those not familiar with the metric system —its advantages and its progress.

The author starts out with this statement:

> For most mathematicians the metric system has a definite lure, because it is completely logical and mathematically perfect.

Later in the same paragraph she says:

> Unfortunately these mathematicians (*referring to the French*) knew little of and cared still less about the mundane world of trade and industry.

The author should know that the very reason for which the French Assembly was called together in 1790 was because of the confusion existing in trade and industry due to the lack of uniformity in weights and measures. One would infer from the first statement that trade and industry should not use a system that is completely logical and mathematically perfect.

The author then summarizes three different investigations on metric usage in South America and Continental Europe respectively by Frederick A. Halsey in 1919, by herself in 1939, and by Arthur E. Kennelly in 1928.

She says:

> A summary of the general conclusions arrived at by the writer as a result of this investigation are:
>
> 1. The customary weights and measures used in trade and industry in the countries studied in continental Europe and South America, where the use of the metric system is compulsory, are those which are most convenient, and so have become a part of the people's thinking such as: the inch, the pound, and the foot. Next to these three in frequency of use in South America are the arroba (25.35 pounds) and the palmo (8.66 inches).
>
> 2. The extent, in general, to which customary weights and measures are used in the countries studied is indicated by the results of the following investigations. See Table I.

TABLE I—A COMPARISON OF THE DATA OF THREE DIFFERENT INVESTIGATORS IN SOUTH AMERICA AND CONTINENTAL EUROPE, SHOWING THE EXTENT OF CUSTOMARY AND METRIC USAGE IN COUNTRIES WHERE THE USE OF METRIC WEIGHTS AND MEASURES IS COMPULSORY

Investigator	Place	Per cent of Customary	Per cent of Metric
Halsey	South America	44	56
Yorke	South America	35	65
Kennelly	Continental Europe	28	72

It would seem that this table gives an excellent argument for the continued use of the metric system as it contributes more than $\frac{2}{3}$ of the units used. The writer has difficulty in reconciling her figures in the table with her statement when she says the customary units were "the inch, the pound, and the foot." From the figures in the table one would say the metric units were the customary in the sense of most frequent. She must use customary in the sense of old and in the table above under Per cent Customary is included ten or twelve other units which are used in South America such as the arroba, palmo, milha, legua, alquerie, quarta, onca, libra, quintal, cuadra and varas. Do not be misled by the table in thinking that the per cents under Customary means inch, pound and foot.

The writer has a copy of Halsey's, "The Metric Fallacy." It was written under stress of argument to meet the wave of

pro-metric opinion that swept over the world in 1919 right after World War I. It is therefor highly biased. An earlier report of his was based on 6,000 questionnaires sent to manufacturers in the United States. This did not represent a random sampling of the population and was likewise highly prejudiced against the metric system.

The author's investigation is likewise biased as is clearly seen from reading the article.

What about Kennely's investigation in Europe? The writer knew Arthur Kennely before he died. He was on the engineering staff of Massachusetts Institute of Technology. He tried to make an unbiased report, undertaken largely for his own information, but he may have been prejudiced for the metric system. The table then gives the results of three prejudiced investigators.

There is one valid conclusion, however, that may be drawn from the table and that is from the figures of Halsey and Yorke. As they both made investigations in South America and they were both prejudiced in the same direction, the fact that Halsey's showed a 56% metric usage in 1919 and Yorke's showed a 65% usage twenty years later proves that there is a definite trend towards metric usage in South America. This is very encouraging.

Lack of space here forbids mention of other inconsistencies, but the author states in two different places, on page 125, second column, and again on page 127, second column, that she makes no attempt to answer controversial questions authoritatively, yet on page 128, in the first column, she says:

> The fifth question, dealing with the metric substitute plan, in the writer's opinion should be answered emphatically in the negative. First, the metric scheme does not operate anywhere as a system.

If this is her opinion no one can deny her the right to it. But the second statement seems to be given with some authority. Let the reader judge as to its veracity.

The concluding remarks in the last column of the article will now be examined. To quote:

> The evidence beyond any doubt makes it clear that it should not be taught as a basic system, which will ultimately replace our present one, because:
>
> 1. The metric system as such exists only on paper.

Is not that a pretty bold statement? Is it true? Where is the evidence?

To continue:

> 2. The twenty-eight metric weights and measures which were legalized in the United States in 1866 are used scarcely at all except in laboratory work, where the gram and cubic centimeter are convenient.

The writer will answer this statement for the reader's information.

The United States became a member of the International Bureau of Weights and Measures meeting in Paris in 1875 and has been meeting with them regularly since then.

The metric system was adopted for medical work in the Navy in 1878.

The meter was made the U. S. standard of length by act of Congress in 1893. The metric system was adopted for medical work in the army in 1894. Congress made it the basis for all electrical work in 1894. It was adopted for public health service in 1902. It was established in Porto Rico in 1913. It was made the legal system in the Philippines in 1917. The Amateur Athletic Association adopted it for official use in 1922. It is now used in the U. S. Coast and Geodetic Survey. It is used by a number of Federal Bureaus in design of armament. It is used by many manufacturing plants. Space prevents mention of them here. It is used in Forestry, Meteorology, Chemistry, Physics, Dietetics and Medicine. Just this year, two noteworthy events took place in connection with the metric system. The American Medical Association in five of its publications will give doses in the metric system only, in 1944 and thereafter. Also the Council on Pharmacy and Chemistry of the A.M.A. has decided that henceforth it will use only

the metric system in publications for which it is responsible. In a recent survey among four prescription pharmacists in Chicago it was found that one reported that 75% of the prescriptions were written only in the metric system, a second reported 70%, a third 40% and a fourth, 25%. We cannot deny that the trend in this country is definitely metricwise.

To continue the author's conclusion,

3. The advantages claimed for metric weights and measures are pure academic theory. In practice they have more disadvantages than advantages.

It would take a page or more to answer this one. The writer will dismiss it with the question, "Is it true?"

4. Just as a nation's language cannot be taken away and replaced over night so its weights and measures cannot be either.

This one is true but it is beside the point for no one has proposed to change to the metric system over night. Rome was not built in a day, and it takes many years to grow an oak. We cannot expect a system so logical and perfect to become fully implemented until after many years. It took 300 years for the Hindu-Arabic system to go from Spain to Italy. The inertia of tradition is very strong as every one knows.

There is an interesting relation between wars and the metric system. We know of course, that war hastens trends and precipitates change. After the Prussian Wars in Europe in 1871, Germany, Austria, Hungary and subordinate colonies adopted the metric system, almost doubling the population then on a metric basis. In 1866, right after the Civil War in this country, the metric system was made legal by act of Congress. In 1920–21 after World War I the metric system was adopted for official use by Russia, China, Turkey, and Japan—thus more than doubling the population that was at that time on a metric basis, It is now officially used by fifty-five of the fifty-seven countries of the world and by more than 75% of its population.

This world wide trend is bound to receive a tremendous boost at the close of World War II, and especially so now since with peace there will be a move towards unification stimulated by the airplane and the radio. The United States will most likely adopt the metric system in trade with South America. England would then follow. It is too late to stop this trend now. And why should we? The best we can do is to teach the simplicity of it in our schools (three units only, the meter, liter and gram) and avoid teaching the conversions. That is what killed the interest in it in the past.

One thing more should be made clear and that is that the reason we have to struggle with conversions which are laborious, time-consuming confusing and error-causing is that there are still two leading countries, United States and Great Britain, that are not using the metric system in their trade with other countries. The issue now is not between the metric system and the English system but between two systems which we have to use and one simple system. Let us hasten the day when conversions will be no longer necessary!

Now is the Time to Buy National Council Yearbooks.
See the ads at the end of this issue!

Also be sure to order the new 18th Yearbook on "Multi-sensory Aids in the Teaching of Mathematics." Ready soon.

New York Regional Meeting of the National Council of Teachers of Mathematics

Teachers College, Columbia University, New York City, February 26, 1944

By EDWIN W. SCHREIBER, *Secretary*
State Teachers College, Macomb, Illinois

THE GENERAL topic of this very successful meeting was: "Mathematics in the Post-War World." Four Panels were held during the morning session as follows:

PANEL I. Mathematics in the Senior High School. Presiding: Julius H. Hlavaty.

"The Place of Mathematics in the Core Curriculum," Max F. Weiss.

"Mathematics in the Senior High School," William D. Reeve.

PANEL II. The Role of Mathematics in the Training Program for Adults and Veterans.

Presiding: Solomon C. Greenfield.

"The Rehabilitation Program—General Considerations," Harold A Weideli.

"The Technical Institute," Lynn A. Emerson.

"The Rehabilitation Program—General Plans for the New York City Schools and Implications to the Teaching of Mathematics," Otto D. Klitgord.

PANEL III. Mathematics in Science and Industry. Presiding: James Naidich.

"Application of Statistics to Science and Industry," J. Wolfowitz.

"Mathematics in Air Transport," Otto E. Kirchner.

"Critical Comments on the Mathematical Background of Aviation Cadets," M. E. Cohn.

"Does the Mechanic Need Mathematics?", Frank E. Woehr.

"An Engineer's Viewpoint on Mathematical Education," P. W. Swain.

PANEL IV. Social and Economic Aspects of Mathematics in the Post-War Period.

Presiding: William L. Schaaf.

"Mathematical Education for a Planned Economy," Harold Hotelling. "Statistics in Business and Economics," W. S. Schlauch.

The luncheon held at the Men's Faculty Club was attended by 225 people. Rolland R. Smith, President of the National Council, presided. The guest speaker, Warren W. Knox of Albany, made a very timely address on "The Place of Mathematics in the Secondary School Program."

The four co-operating organizations who planned the above program are: Standing Committee on Mathematics in New York City, Chairman, Dr. Eugenie C. Hausle; Association of Chairmen of Departments of Mathematics of New York City, President, Mr. Benajmin Braverman; Section 19 (Mathematics) of the New York Society for the Experimental Study of Education, President, Prof. William L. Schaaf; Association of Teachers of Mathematics of New York City. President, Mr. Max Peters.

Dr. Nathan Lazar, Midwood High School, Brooklyn, N. Y., was chairman of the Program Committee, ably assisted by the chief officers of the above organizations.

A very interesting Mathematical Exhibit was prepared under the direction of Professor W. D. Reeve which was much appreciated by those who saw it.

The Annual Meeting of the Board of Directors occurred in three sessions, on Friday morning, Friday afternoon, and

REPORT OF THE TREASURER

EDWIN W. SCHREIBER, *Macomb, Illinois*

For the Year, Feb. 1, 1943 to Feb. 1, 1944

Balance on hand at beginning of year:			
Union National Bank of Macomb	$1,537.69		
Savings Bank Deposit	2,205.68		
Commonwealth Edison Bond, 3½%, June, '68	2,072.08		
	$5,815.45		
Net loss on Book Value of Bond	1.86		$5,813.59
Receipts for the Year:			
MATHEMATICS TEACHER, W. D. Reeve	$1,565.48		
Bureau of Publications, Year Books	0.00		
Interest on Bond	70.00		
Interest on Savings	22.05		
17th Year Book Committee	26.95		
Chicago Regional Meeting	4.95		1,689.43
			$7,503.02
Expenditures for the Year:			
Chicago Regional Meeting:			
Directors' Expenses	$ 607.98		
Local Committee	32.93	$ 640.91	
Oother Regional Meetings		181.65	
President's Office		100.00	
Secretary-Treasurer's Office			
Postage and Supplies	$ 150.00		
Ballot	150.00		
Secretary Service	300.00		
Stationery	40.00		
Bank Box	4.80		
Incidental Expense	30.50	675.30	1,597.86
			$5,905.16

Statement of Assets in the Treasurer's Office

Commercial Bank Deposit	$1,587.71		
Savings Bank Deposit	2,247.23		
Commonwealth Edison Bond	2,070.22	(1943)	(1942)
	$5,905.16	$5,815.45	$4,475.31

(Signed) EDWIN W. SCHREIBER, *Treasurer*

The above report has been audited and found correct.

(Signed) W. S. SCHLAUCH, *Auditor*

Saturday afternoon. The Directors present were: Rolland R. Smith, Dorothy S. Wheeler, Edwin W. Schreiber, William D. Reeve, W. S. Schlauch, Kate Bell, J. O. Hassler, L. H. Whitcraft, A. R. Congdon, A. Brown Miller, Hildegarde Beck. Directors absent: Edwin G. Olds, Vera Sandford, Ina E. Holroyd, H. W. Charlesworth, Veryl Schult. Others present: Raleigh Schorling, John P. Everett, William Betz, Martha Hildebrandt, H. C. Christofferson, Mary A. Potter, F. Lynwood Wren, Carl N. Shuster, John R. Clark, Virgil S. Mallory. Routine business was transacted and the following committees appointed: *Yearbook Committee*, Chairman, William D. Reeve, A. Brown Miller, Virgil S. Mallory. *Public Relations Committee*, Chairman, Mary A. Potter, J. O. Hassler, Veryl Schult. *Post-War Committee*, Chairman, Raleigh Schorling, Eugenie C. Hausle, William Betz, Rolland R. Smith. Secretary Schreiber announced the results of the annual election: For

President, F. Lynwood Wren, Peabody College, Nashville, Tenn., for Second Vice-President, Miss Edith Woolsey, Minneapolis, Minn., for three Members of the Board of Directors, Prof. E. H. C. Hildebrandt, Evanston, Ill., Carl N. Shuster, Trenton, New Jersey, Ruth W. Stokes, Rockhill, South Carolina.

VOTE BY STATES

Ala.	8	Ga.	4	Md.	8	N. H.	1	Pa.	26	Wash.	15
Ariz.	2	Ida.	0	Mass.	18	N. J.	49	R.I.	2	W. Va.	2
Ark.	2	Ill.	104	Mich.	21	N. Mex.	2	S. C.	19	Wis.	28
Calif.	45	Ind.	27	Minn.	24	N. Y.	62	S. D.	3	Wyo.	3
Colo.	13	Iowa	27	Miss.	4	N. C.	7	Tenn.	10		
Conn.	11	Kans.	22	Mo.	16	N. D.	1	Tex.	11	TOTAL	716
Dela.	3	Ky.	5	Mont.	0	Ohio	31	Utah	1		
D. C.	10	La.	15	Nebr.	11	Okla.	10	Vt.	1		
Fla.	11	Me.	1	Nev.	1	Ore.	6	Va.	13		

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Evander Childs H. S.
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Marks, Ethel R.
Theurer, Elsie
Fred Douglass Jr. H. S.
Landau, Saul
Geo. Washington
Barrners, Ruth
Dilthey, Elizabeth
Haaren H. S.
Finkel, Irene
Grudin, Lillian
Nadler, Maurice
Stein, Ethel S.
H. S. of Com.
Mamro, Thomas
H. S. of Mus. & Art
Matzke, Adele
Starr, Joseph
Zalosh, Hyman
Hunter College
Landau, Dorothy B.
James Monroe
Berenson, Sarah
Butler, Lovilla L.
Hausle, Eugenie
Weiss, Rose E.
Junior H. S. 12
Miller, Ruth
Junior H. S. 120
Wayne, Alan
Long Island City
Peters, Max
Manhattan College
Allfred, Bro. Bernard
Morris
Sackman, Jennie B.
New York Univ.
Schlauch, W. S.
Schutzman, Wm.
Rudolf Steiner
Harver, Wm.
Seward Park H. S.
Brahdy, Marie
Braverman, Benjamin
Greif, Netty L.
Stuyvesant
Berman, Simon L.
Greenfield, Samuel
Wortman, Jacob
Textile H. S.
Sheinberg, Rose
Theo. Roosevelt H. S.
Lustig, Emilie
Washington Irving
Zagat, Lillie
Wm. H. Taft H. S.
Dichter, Samuel
Others from N. Y. C.
Roll, Rose
Secor, May
Southard, Almira
Knudsen, Ellen
Boros, Arnold L.

Bayport
Ormsby, Elizabeth
Catskill
Kotler, David
Cortland
Sueltz, Ben A.
Forest Hills
Hellwig, Eileen F.
Freeport
White, Mabel C.
Garden City
Osteyee, George
Glen Cove
Keeney, Vera
Ithaca
Emmerson, Linn A.
Jamaica
Bergstresser, Clinton
Bay Side, L. I.
Adler, Irving
Schwarzbach, Olga
Floral Pk., L. I.
Bauer, Grace
Clark, John J.
Hollis, L. I.
Miller, Grace
Lawrence, L. I.
Wood, Florence
Long Island City
Frank David H.
Mineola
Orr, Bessie M.
Mount Vernon
Brown, Florence
New Rochelle
Carroll, L. Grace
Pelham
Peeler, Harry
Richmond Hill
Kriegel, Isabel
Schenker, Pauline
Seith, Ellen E.
Rockville Center
Reeve, Alice M.
Rochester
Betz, William
St. Albans
Ericksen, Elsie
Sayville
Burgle, Harviett
Scarsdale
Rose, Carroll
Staten Island
Magee, Margaret
Feman, Harry G.
Yorktown
Bierce, Marjorie

Oklahoma

Norman
Hassler, J. O.

Ohio

Oxford
Christofferson, H. C.
Cleveland
A. Brown Miller

Pennsylvania

East Stroudsburg
Burrus, Marvin E.

Tennessee

Nashville
Wren, F. Lynwood

Virginia

Norfolk
Alston, Melvin

Wisconsin

Racine
Potter, Mary A.

Washington

Spokane
Bell, Kate

The First Report of the Commission on Post-War Plans[1]

THE MEMBERS of this new Commission are not disposed to

1. Make hay while the sun shines and thumb our noses at recalcitrant administrators;

2. Gloat over some educationists by saying "We told you so";

3. Defend our work against the charge that the real Pearl Harbor occurred in our classrooms;

4. Berate guidance officials for not presenting realistically the mathematical needs of youth in a machine age;

5. Condone our numerous sins of omission in the past;

6. Argue that the traditional program cannot be greatly improved;

7. Place the blame for low competency in arithmetic on overworked teachers of the elementary school;

8. Elbow our fellow teachers in other school areas; nor

9. Campaign for larger enrollments in our four-year sequential courses.

But we are asking discerning school people and thoughtful laymen for good ideas and definite suggestions from which a sensible report may later stem that will provide adequate training in mathematics for *all* students in our schools—each according to his needs. We assume that in a peaceful world what is best for the individual will be good for society.

In a recent meeting of the Board of Directors of the Council about ten tasks were suggested as the job of this Commission. If we get the help of a goodly number who are desirous of building a sound program of mathematical education, we may later be able to do some of the things expected of us. The Commission is authorized to increase its membership and to appoint subcommittees for specific tasks. It wishes to limit its membership to a manageable size, but it stands ready to welcome to advisory membership any teacher of mathematics representing a large organized group. For example, it is hoped that the two city clubs in Chicago, long active with high zeal, will select someone to represent them and that the California Mathematics Council, because of its size and its praiseworthy activity, will select two—possibly a woman and a man. Perhaps these illustrations will be sufficient to guide other groups to appropriate action. As concrete evidence of confidence in its representative it would seem desirable for a local group to provide from $25 to $100 per year to be used for secretarial assistance, expenses to meetings, and the like. In these days when powerful pressure groups appropriate millions to achieve specific purposes it might be wholesome for a local organization to spend a modest sum in an effort to improve the quality of its work for the general good of society.

In order to promote discussion during the summer months, particularly in workshops and professional courses the Commission presents the following list of proposals which, we think, should be carefully considered by many persons in planning our work for the post-war years. It is perhaps needless to say that these statements do not express the unchangeable views of the Commission. On the contrary they are printed here in this early stage of the Commission's work with the hope that you will send a carefully prepared statement to some member of this Commission setting forth your recommendations regarding these issues and any others that may seem significant to you.

[1] At a meeting in New York City, February 25, 1944, the Board of Directors of the National Council of Teachers of Mathematics created a commission to plan mathematics programs for secondary schools in the post-war period. This brief preliminary report represents a first step in the work of the Council's new Commission. Reprints of this report may be had from The Mathematics Teacher, 525 W. 120th St., New York 27, N. Y. for 10¢ each postpaid.

Tentative Proposals for a Post War Program in Secondary School Mathematics

1. *The school should insure mathematical literacy to all who can possibly achieve it.* The need for simple computations and for control of certain basic mathematical concepts is well nigh universal. The war has demonstrated in a dramatic way what is nonetheless true, but not so readily discernible in peace time, that a boy lacking these competencies is a pathetic victim of a ruthless system. In the armed forces men are so badly needed that they are expected to learn the impossible overnight, but in peace times they shift from job to job and finally drift unnoticed into the ranks of the unemployed. In a world in which the questions "how much?", "where?", and "how many?", have to be answered again and again accurately and with great precision, mathematical literacy is almost as important as the ability to communicate.

Man, through his age-long study of natural phenomena, has discovered the world to be orderly, predictable, knowable. With the use of an adequate number system, methods of precise measurement, and controlled experiment he has progressively discovered more and more relationships significant to him. The use of these discoveries produced the "industrial revolution," a scientific and technological culture.

An understanding and appreciation of the important elements of this culture, one of the admittedly valid aims of education, are contingent upon possession of certain basic concepts and principles from the areas of mathematics, biology, physics, chemistry, geology, and other sciences. These concepts and principles are the instruments without which man cannot think intelligently about machines, housing, business, transportation, communication, public and personal health, investments, insurance, or scientific inquiry. An understanding of these aspects of modern life demands a common language of quantitative symbols, fundamental operations, and basic ideas of arithmetic, of algebra, and of geometry. Thus, the function of mathematics is largely identical with that of reading and writing.

Modern culture is dynamic. Only change appears constant. New adjustments are sought; new problems demand solution. We desire more adequate food, clothing and shelter; we wish to reduce economic insecurity; we are determined to conserve our natural resources; we seek more wholesome uses of leisure; we need more efficiency in government. A better civilization is to be created.

The place of science and mathematics in the education of youth thus becomes obvious. To understand the modern world, and to think intelligently about its problems is a broad purpose of general education, and is served in an essential way by the instruction with which we are here concerned. Subject matter which implements this purpose is here termed "educational"; it is the body of material that has intimate and demonstrable relationship to the business of living.

Without a minimum mathematical equipment, the individual is in a mental concentration camp of cruel limitations in which the creature comforts that he can earn for himself and the good he can do for his fellowmen are pitifully small. On this point, the recent reports of two committees[2] are completely convincing. Witness the fact that there are several hundred thousand men at least in the armed forces who are undoubtedly a liability, because they cannot in the short time available acquire the needed mathematical equipment without excessive cost. From the point of view of the educated person, the minimum mathematical equipment needed in common affairs is absurdly simple. But the task of insuring mathematical literacy

[2] See "Pre-induction Courses in Mathematics" in *The Mathematics Teacher* for March 1943 and "Essential Mathematics for Minimum Army Needs" in *The Mathematics Teacher* for October 1943.

to all people is enormously difficult—one that has not been done in any community throughout all history. It will take time, energy and money. Moreover, there is no reason to believe that technology will cease to develop. The job facing mathematics teachers is almost certain to be more difficult and more important in the years ahead. It is a challenge that mathematics teachers should accept.

2. *We should differentiate on the basis of needs, without stigmatizing any group, and we should provide new and better courses for a high fraction of the schools' population whose mathematical needs are not well met in the traditional sequential courses.* Teachers of mathematics generalize quickly, they learn to manipulate symbols easily and we tend, as years go by, to get more and more impatient when providing experiences from which meanings grow. We are prone to call the unadjusted pupils "slow learning." They are by no means all dull and in any case, hundreds of thousands of them are at the moment literally saving our institutions by the mathematics that they have learned since leaving school. We have had too many dissatisfied customers. The educationist and the administrator have sensed the situation but they over-simplify the problem when they advocate no mathematics for the "forgotten student." We sit in endless meetings discussing the question: shall we give special attention to the bright or to the dull? It is not an either-or proposition! The sensible thing to do is to provide good courses with very different goals and different experiences for groups with different needs.

To redirect our thinking, this Commission proposes that we provide three series of courses as follows: *sequential mathematics, related mathematics,* and *social mathematics.* By sequential courses we mean the four years of work (grades 9–12 inclusive) providing rigor and continuity and to be obtained by greatly improving the traditional sequence: algebra, geometry and trigonometry. By related courses, we mean courses that will meet the needs of the large number of persons who will continue to be absorbed by industry fairly early in life—such courses to be obtained by improving the existing general mathematics courses. Far too many boys entered the armed forces unfairly handicapped, because they came from good schools where they had no adequate experience with scale drawings, maps, graphs, micrometers, Verniers, gage blocks, metric system, practical constructions, logarithms, and basic concepts of trigonometry. Yet, these are among the very things that would have added vitality and meaning to the abstract symbolism and theory which their former mathematics teachers struggled to teach them. General mathematics courses can be improved by new emphases and a few carefully selected, simple and realistic illustrations for each bit of theory. The proposed courses would be valuable to many persons who never go into industry and vastly more satisfying and helpful to many students who never really know "what the score is" in the traditional courses. We confidently predict a sharp increase in technical education, and mathematics teachers should stand ready to contribute a very important part to the movement.

But we need a third series of courses—courses that will insure mathematical competency in everyday human affairs. In the postwar period, we may manage to get along without rationing, ceiling prices, subsidies, parity and inflationary spirals. But there surely will be problems that affect a large fraction of our people. We will have problems of taxation, of social security, of insurance against the numerous hazards of life, and we will have the persistent problem of stretching the dollar in order to buy the maximum of creature comforts and values with a given income. Competency in these crucial matters apparently cannot be left to chance—even insight and common sense need to be exercised in meaningful situations. The need for mathematics in these problems goes far

beyond mere manipulation of the fundamentals. The general educationist has long urged a social mathematics course. He has been trying to do us a favor, which some of us stupidly interpreted as an attack on our work. We should now seek his aid in creating such courses.

It will be pointed out and truthfully that the sequential, related and social mathematics courses overlap; that the social mathematics courses may contain material related to industry and commerce, that the related mathematics courses must at times take into account the social implications, and that to the discerning boy and girl the sequential courses may be both practical and social. Let us admit this. However, in an earlier day the traditional classification of mathematical goals, cultural, disciplinary and utilitarian was useful though obviously these terms also overlapped. In like manner, the phrases *sequential mathematics*, *related mathematics* and *social mathematics* may in the years ahead be useful in identifying three types of mathematics courses—three emphases if you like—that differentiate according to needs. In any case, the committee welcomes better names for these courses if anyone can think of them.

This differentiation should be done without stigmatizing any group. In far too many schools, the mathematics program has been seriously weakened by the general impression that the traditional courses were the *only* respectable ones, and that successful completion of them implied prestige and acceptability. How can we avoid stigmatizing the more general and the more practical courses? We can do this by making clear to pupils that the courses have different goals and different experiences for people with different interests, by taking more into account than the scores on intelligence tests when classifying a pupil, for example, his ability and his desire to do the course at a fine level; and by removing the halo from the traditional courses. The sequential courses will always command respect because they are rightly associated with admission to professional schools requiring technical courses, but this fact need not and should not imply disrespect for the other courses.

For a generation to come, at least, the mathematics related to a simple kind of physical science should be highly regarded by a grateful world. In the depression days our dissatisfied customers drifted out of school, accumulated in out-of-school unemployed youth and piled up in C. C. C. Camps. The schools of the armed forces have taken these boys, incidentally teaching a lot of them mathematics, and have in general achieved an intense concentration and a spirit of industry that may not be altogether accounted for by the unusual motivitation for which it must be admitted there is as yet no peace time equivalent. It is possible that better adjustment is due to the fact that the training courses in the armed forces are to a greater extent organized in terms of ability to do. The mathematics classroom of the armed forces is likely to take on the atmosphere of a workshop with more realistic problems, more laboratory materials, especially visual and auditory aids. Curiously enough, the actual text materials in the hands of the enlisted man is more often than not hopelessly shoddy as regards both scholarship and pedagogy and may be taught by a young instructor without special training and experience and with no desire to teach. Add to this the fact that a goodly fraction of the enlisted men dislike things military and find their particular location extremely distasteful. But the results achieved, especially as regards a driving spirit of industry and zeal for the task is something we need to study before we conclude that simple technical mathematical courses cannot be made attractive to young people.

Nor should there be any problem about popularizing social mathematics. It is the type that some of the intelligent citizens of our communities want us to teach. When Phi Beta Kappas have trouble

stretching the dollar, so as to stay within the family budget, and when the framers of the income tax law need help in computing their income taxes, we are operating at the level of respectability if we succeed in giving our students some understanding of these vital and persistent problems.

The main thesis then of the Commission is that there are neglected groups of students—very large ones—whose needs cannot possibly be met in traditional courses.

3. *We need a completely new approach to the problem of the so called slow learning student.* In general, the schools of the armed forces have in all probability provided more appropriate learning situations for this type of student. The problem of the unadjusted in our schools involves more than mathematics,—it touches all that the school provides for this group. Indeed, when taught by a good teacher, the adjustment of the slow learner to mathematics may be fully as good as to other school subjects. We need to place the slow learner in a small universe of things that need to be managed, and which demonstrate the simple and basic concepts of mathematics. The need is for a laboratory or a work-shop type of setting. It is the only way to keep meanings ahead of manipulation and to build for confidence by avoiding confusion and frustration. As professional workers, we must provide an adequate education for the slow learning student, because as a human being, he is entitled to it. Society dare not neglect the problem, because its institutions are forever in danger when the uneducated masses become restive by the annoying gap between the things that they can have, and the things that they want. Mechanizing a nation which is not mathematically literate is a dangerous business. The problem of the slow learner is a world problem. It is crucial in our land. It calls for a different curriculum and a new approach. It demands a new program in mathematics that we should provide.

4. *The teaching of arithmetic can be and should be improved.* The widely publicized letter by Admiral Nimitz dramatized the alleged shortage in arithmetic to the public. It would be futile to point out that this drastic indictment was based on wholly inadequate data collected by outmoded tests, for the reason that the main observation of low competency in arithmetic is amply supported by data available to school people for more than a decade. The average score on any test item be it arithmetic, history, or any systematic study submitted to a large unselected group is likely to be shockingly low to those who do not realize how very difficult it is to teach any specific fact or skill to complete mastery to all the children of all the people. Nor is it necessary for teachers of mathematics to waste time and energy defending their work. As the war drags on, selective service is coming much closer to scraping the bottom of the barrel of human material. The young instructors in the armed forces are getting a small sample of what the mathematics teacher in the regular school is up against day after day. Already the opinion is widespread among instructors in the armed forces that, on the whole, teachers of mathematics of our schools have done "a whale of a good job."

But this doesn't mean that competency in arithmetic should not be far higher than it is. As one sees grown up men by the hundred thousand struggle with very easy decimals, one wonders whether anything in our school is taught in worse fashion than decimals. And decimals, it should be noted, are as crucial in industry as they are in the armed forces. We are not going to lay aside our micrometers, verniers, gage blocks and decimal system the moment the war stops. How shall arithmetic be improved? By striking at the crux of the problem—the education of teachers. In the last generation, professional courses for teachers dealing with the teaching of arithmetic have practically disappeared from our teachers colleges, with the result that most beginning teachers do not know how to teach arithmetic. In fact, some actually fear it and escape the task by excessive attention to other activities in

which they feel more confident. To make matters worse, many are tempted to teach the little they do teach by the incidental method—presumably the ideal method, but also the most difficult which only a few per hundred could manage even if they had good training. The right kind of professional courses should be made available at once to every prospective teacher of the elementary school. Naturally the details of both content and method of such courses must be provided by the gifted arithmetic teachers of our times. Could you, by chance, be one of these? If so, this Commission needs your help.

The simplicity of mathematical skills needed by the masses in the armed forces is even greater than was generally assumed, but is, as has been pointed out elsewhere, very difficult for many persons to achieve. Provision for growth in the mastery of arithmetic should be continuous throughout the elementary and secondary schools. Achievement of ability in mathematical reasoning and in sensible use of mathematical concepts requires much time and continuous practice. Courses of study of the elementary school should be reconsidered and adequate time be given to the teaching of arithmetic. Moreover, we have not given enough attention to arithmetic in teaching the senior high school courses. In fact, we have too often allowed the fundamental skills to deteriorate. Hereafter, we should keep an eye on arithmetic as we teach the advanced courses. Finally, the administrator can't eat his cake and have it. If we are to be held for results, we need to have the students for whatever time it takes to do the job.

5. *The sequential courses should be greatly improved.* The mathematical requirements of technology are far greater than has been generally assumed. Leadership in these fields presupposes an extent and range of mathematical scholarship far greater than schools have traditionally made available. A fraction of the schools' student body—unfortunately no one knows how large—will need more mathematics than educators or even mathematics teachers, have realized. The mathematical demands in training schools for radar, radio, fire control, navigation, air photography, map making, orientation and a goodly number of other areas—needs that will continue in peacetime—far exceed what can reasonably be expected of graduates of our four year sequence. There has been no criticism or complaint because of this shortage. But the fact is that these fields took all the mathematics a good student could bring "and then some." Witness the fact that a few young men with the Ph.D degree in mathematics are taking evening courses at the end of long days of toil, in order that they may better meet the mathematical demands of their task. The road to achievement in science and mathematics is very long. The last years of the high school should be wisely used by persons who plan to enter these fields.

When taught by good teachers to qualified students, the sequential courses are as well liked as any that are offered by our schools. Even before the war got under way a *Fortune* poll showed mathematics to be the best liked subject in the high school curriculum. (Note well—also the least liked.) Military authorities are on record to the effect that the product of the four years' sequence is highly satisfactory as a pool of leadership for the armed forces. Men of culture in all lands have for centuries rated high a control of algebra as the universal language, a concept of the nature of proof as a guide to sound thinking, and a knowledge of trigonometry as a practical tool for problem solving. Few people, if any, who have done traditional mathematics courses at a high level question these values. Nor, are there many who doubt the value of learning to deal systematically and symbolically with the data in the more general problems of society involving quantitative thinking.

Even more important is the fact that the age old debate on transfer is finally "out of the window." In the military activities, countless young men learned some-

thing new overnight and over twenty million workers changed jobs last year. The authorities have assumed that a worker could adjust quicker and better to situation *B*, because he had lived through situation *A*. If this assumption had not been sound, it might have taken us ten years to get on with a machine war. It is significant that no writer of insight and prominence has challenged or even questioned the case for the disciplinary values, as published in the Report of the National Committee on Mathematical Requirements twenty-one years ago. That brilliant and sensible statement of disciplining values has stood the test, and it now guarantees that mathematics will be an important part of the education of some of our youth for a long time to come.

But no one should assume that all is well with the traditional courses. In most schools, they are woefully out of date, as regards both subject matter and method. The report just mentioned, and the two more recent committee reports, included many splendid recommendations that represent the convictions of good teachers of mathematics everywhere. But there are a lot of schools that have never checked their offerings with these recommendations. How shall the traditional courses be improved? The answer is by a far reaching change in each of the three factors involved, the pupils, the materials, and the teachers.

As regards the pupils, the traditional courses should be reserved for pupils who can do these courses, and who want to do them. The door to the four-year sequence should be wide open, but no one should be shoved through it. Failure should, for the most part, be avoided by proper guidance to other appropriate mathematics courses. The unique values of the traditional courses cannot be achieved by a constant gearing down, nor by the inclusion of popular material in a futile effort to meet the mathematical needs of pupils who should not have elected the course in the first place. The materials should be brought up to date by substituting realistic problems for fantastic and outmoded ones. A wealth of vital problem material is now available. The job of the mathematics teacher now is to select a few good applications for approach, and for drill on each major concept and to manage these, so that neither he nor his students will be lost in applications, but will keep the organized principles and concepts of mathematics at the focus of attention.

The war has revealed that the standard training of mathematics teachers is inadequate. Too many lack familiarity with a vast range of uses of mathematics; for example, aviation, industry, trade, business, statistics, engineering and sciences in general. It will be difficult for some to teach, not to mention create, the wider diversity of courses that the new era demands. The undergraduate program for teachers should include at least a one year course which correlates industrial arts, a practical kind of physical science and the related mathematics. The mathematics teacher of the future must know more about the technical world, and the gap between pure and applied mathematics in the present program needs to be closed.

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◆ THE ART OF TEACHING ◆

Vocabulary Building

By Miss Alice N. Tucker
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In no subject in the school is there greater need for rigor in defining technical words than in geometry. Here the very nature of definition is brought out in great clarity as we list all salient attributes of a figure and select one which we arbitrarily decide shall be the definition. So it is a matter of selection on the part of the author of a text book, or perhaps a national committee, whether a circle shall be defined as a curved line (modern) or the space enclosed by such a curved line (fifty years ago). One author may elect to define square as a kind of rectangle; for instance, a rectangle with one pair of adjacent sides equal. Another may say that the definition of rectangle stipulates that the sides be unequal.

In the main we seek the definition which has the fewest assumptions. It is considered more elegant. Thus if we define rectangle as a parallelogram with one right angle rather than a parallelogram with four right angles, we have no excess baggage in our definition. For, if one angle is a right angle, the others must be right angles, according to the properties of a parallelogram.

Words are defined in terms of other words. Ultimately, one either makes a chain which returns upon itself, or he enters upon a never-ending series. For example:

A chain.
A point is a dot.
A dot is a position.
A position is a place.
A place is a spot.
A spot is a point.
A series.

A point is a position, and a position is a place without dimension. And so it becomes necessary to explain the meaning of dimension—and size—and then space—and all the other ideas which arise, . . .
ad infinitum

We describe "point." We *know* what a point is. Let it go at that and accept it as an idea, perfectly clear and definite but without definition. The important consideration is that the very nature of definition and its relationship to undefined ideas be understood.

A feeling for exactness of thinking and, as a necessary concomitant, exactness of speech can be developed in the mathematics classroom. Here, students are introduced to preciseness of expression. It is in a class led by a real teacher who himself has an enthusiasm for words and a respect for their meaning that the student begins to curb his own loose usage. And here too, perhaps, he gains a desire to express himself accurately and he develops a liking for nicety of phrasing and an impatience with vague speech.

If all this could be accomplished, even though it be a by product, it would be reason enough to study geometry.

EDITORIALS

Mathematics in the Post-war World

IT NOW SEEMS pretty clear that if mathematics is to continue to hold the high place it now occupies among the great fields of knowledge in the secondary school curriculum and in the public esteem, the following things must be kept in mind and something worthwhile be done to carry out the improvements and changes suggested by them:

1. *Arithmetic in the elementary school must be reorganized for teaching purposes and those who teach it should be required to know more about the subject than too many of our teachers do at the present time.*

While the recent poor showing on Admiral Nimitz's test[1] of the 4,200 entering college freshmen who wished to enter the Naval Reserve Officers' Training Corps shows a small residue of skills and ability to think with arithmetical concepts, we know that "by a short period of intensive, systematic practice with well prepared materials" high school seniors can improve their skills[2] greatly. This fact shows, in some cases at least, that the teaching may not have been altogether bad. However, we know that the teaching of arithmetic needs to be improved and that the time is ripe for the improvement to start.

2. *Prospective teachers must be better trained to teach mathematics in the schools and those who are already teaching should be improved while they are in service.*

The above point is corollary to the first and applies equally well in all grades in school. We have too many poorly prepared teachers, and since the war began the situation has become much worse, because many of our best teachers have gone into some form of war service or industry. If we are to require better trained teachers we must insist that salaries be increased. The low salaries paid to teachers in the schools is a national disgrace. Most people know it and some people complain about it, but as Mark Twain once remarked about the weather, "Everybody complains about it, but nobody does anything about it." After the war is over we must attract more people, especially men into the teaching profession by paying them salaries equal to what they can get in business and industry. The war has shown that many of our women teachers can take their places in industry and earn salaries far greater than they were paid for teaching. Unless teachers are better paid, the most capable women, as well as the men, may be tempted to enter other lines of work. Some teachers will not quit teaching unless forced to, because they love to teach, but it is becoming increasingly hard to carry on in view of the tempting offers outside the teaching profession. An interesting story concerning a science teacher who was compelled to give up teaching is told on page 78 of *The Journal of the National Education Association* for March, 1944.

Speaking on "The Role of the Educator" recently, Mrs. Eleanor Roosevelt said:

> The role of the educator is the most important thing before the country today. We have to find a way of making it possible for the country to give equal opportunity to our youngsters. I know how hard it is with the feeling in many places that education is a secondary interest. "Why should teachers be paid higher salaries? Why should they have so much preparation? Look what an easy life they have—so many months of holiday!" It must be disheartening. It must make teachers feel that nobody recognizes how important is their role.[3]

[1] See "The Importance of Mathematics in the War Effort." Editorial in THE MATHEMATICS TEACHER, February 1942, pp. 88–89.

[2] See Brueckner, Leo J., "To Serve War Needs." *The Journal of the National Education Association* for October 1943, p. 203.

[3] See page 59 of *The Journal of the National Education Association* for March, 1944.

Once adequate salaries are paid we must insist that teachers be prepared to teach. No one should be permitted to teach mathematics who has not had sufficient training. This means that teacher training institutions must raise their requirements. We have had an oversupply of teachers in the past, but we have never had an oversupply of good teachers. Some kind of minimum standard should be maintained if we are not again to be embarrassed by the performance of the youth who go through the secondary school.

3. *The mathematics of the junior high school years (7 to 9 inclusive) must be completely reorganized.*

There are many school buildings in the United States upon which the name "Junior High School" appears, but once you enter the mathematics classes you realize it is largely a misnomer. You will find the same old arithmetic. In many cases the arithmetic is poorly taught.

Some of the responsibility for the lack of interest in and support for junior high school mathematics of a modern type rests upon the senior high school teachers, many of whom not only look down on those in the lower grades, but also are opposed to the introduction of the more modern treatment of *informal geometry*. Those who take this attitude doubtless do so because they do not realize that the purpose in teaching informal geometry is different from that of formal geometry in the senior high school. Moreover, if informal geometry is taught in the junior high school, some of the simpler ideas of algebra can be presented, such as simple rules of procedure and their formulas, the four simple types of equations, graphs, and directed numbers.

Betz recently made a good case for informal geometry when he said:

> For generations the mathematical program of the elementary school has been limited almost entirely to arithmetic. Only the higher grades constituted an exception to the extent that it was customary to include some work in practical mensuration. This arrangement overlooked the fact that mathematics has a dual foundation—arithmetic and geometry. Number and form, counting and measuring, appeared on the scene together, for number was the indispensable tool of measurement, and considerations of shape, size and position accompanied even the primitive artisan in all his practical activities. Thus it was that the geometry of everyday life, often called intuitive or informal geometry, preceded the development of demonstrative geometry by thousands of years. And it is this kind of everyday geometry which we must have as one of the cornerstones of the mathematical edifice. Its virtual omission has given us the lopsided, distorted curriculum to which may be traced many of our mathematical troubles in the high school.
>
> The arrival of the junior high school movement marked the beginning of a more serious effort to restore the "missing link" of mathematics to its rightful place, especially since the appearance of the National Report of 1923. Slowly, and often in very imperfect fashion, the necessary geometric material began to make itself felt in the textbooks and syllabi. But a great deal of improvement is still necessary. The war situation may well mark a turning-point in our notorious indifference to the claims of geometric instruction. All pre-induction syllabi in mathematics have stressed the essential character of a dependable geometric training. They demand a knowledge of geometric forms and concepts, skill in direct and indirect measurement, familiarity with basic constructions, with scale drawing, blueprint reading, map reading, and the like. For nearly a century American mathematical leaders have demanded a coordination of geometry and arithmetic. That step has long been taken by all other leading nations. We cannot afford to postpone it any longer in our American schools.[4]

If and when we finally realize the importance of this aspect of mathematical training for our youth, the teacher training institutions throughout the country must include such work as a part of their required training for all teachers in the junior and senior high schools.

4. *Senior high school mathematics must also be reorganized. It should be a continuation of the general mathematics program of the junior high school with demonstrative*

[4] Betz, Wm., "Next Steps in Education and in the Teaching of Mathematics." *The National Mathematics Magazine*, January 1944, pp. 167–168.

See also Coleman, Robert, "The Development of Informal Geometry." Teachers College, Columbia University, Contributions to Education, No. 865. Bureau of Publications, Teachers College, Columbia University, New York, 1942.

geometry (plane and solid) furnishing the core for the tenth grade, followed by algebra and trigonometry as the core of the eleventh year with the simpler elements of analytic geometry brought in where feasible.[5]

In some quarters attempts have been made to improve the situation by setting up a so-called *terminal course* in mathematics for the ninth grade. This without question has been a fatal mistake for all concerned. There is no place for the idea of a terminal course in any year. The door of mathematics must be kept wide open for those who will want it and need it throughout the senior high school. It need not be required, but it must be taught as though salvation depended upon it.

5. *Those who teach mathematics must find out not only how pupils learn but how they learn most easily and effectively.*

This implies a new emphasis upon meaning and understanding and less upon mere skill and the automatic functioning of principles of operation. *Speed* is important, of course, in learning the skill operations, but *accuracy* is the more important goal. It involves the whole question of transfer of training about which so much has been said in recent years, but about which very little has been done insofar as the improvement of learning is concerned. We know that transfer exists, but we also know that it does not happen miraculously as some overzealous mathematicians would have us believe. Moreover, we know that if the teacher is to get anywhere, he must know not only what transfer he wishes, but also the best method of securing that transfer in the classroom and in life situations outside.

6. *The unusual emphasis which is being given to mere practical applications during the war without connecting them with underlying mathetical principles should be reduced in post-war years.*

If we accept the premise that in a democratic society each individual be given the opportunity to develop his potentialities as fully as possible, then it follows that the main emphasis should be placed upon the importance of the more general application of principles for a large number of pupils.

This does not mean that practical applications will not be made, but they should be made for purposes of motivation and in cases where such applications will help the pupil better to understand basic ideas and how they can be transferred to real life situations.

7. *Much greater attention needs to be given to the matter of individual differences in ability among pupils in the schools.*

This involves the necessity of classifying pupils into more homogeneous groups for teaching purposes only. The most retarded pupil in the secondary school today is the gifted pupil or the pupil of scholarly mind.[6] Moreover, the pupils of lower ability need to be able to go at a rate of learning that will enable them to accomplish something worthwhile even though it be far less than may be learned by the more gifted group. Failure to recognize individual differences or failure to do something about them or both results in an enormous loss of learning.

Some people say that to classify pupils into homogeneous groups is undemocratic. This cannot be proved by the facts. In a democracy, if anywhere in the world, leadership is essential, but it is also necessary to have intelligent followership. This can never happen to so great an extent as

[5] The question as to what should be the content material for the senior year of the high school is still somewhat unsettled, but some good plan can be worked out that will be better than what we have at the present time. For some it will include a half year course in social and economic arithmetic and a simple introduction to the fundamental ideas of the calculus. For others the course may be different. For more detailed suggestions, see the Fifteenth Yearbook of the National Council of Teachers of Mathematics, published by the Bureau of Publications, Teachers College, 525 West 120th Street, New York City.

See also Betz, Wm., *op. cit.*, pp. 161–162.

[6] See Reeve, W. D., "Mathematics and the Integrated Program in Secondary Schools." THE MATHEMATICS TEACHER, April, 1937, pp. 155–166.

we might have with better class organizations.

8. *Mathematics teachers need to work in closer cooperation with teachers in the other great fields of knowledge.*

We hear a great deal these days about the importance of *integration.*[7] This is a psychological word and refers to what goes on inside the pupil rather than between parts of subject-matter, but we use it here because it is the word now in vogue. Correlation would be a better term.

If the *Core-Curriculum* idea is to have any chance of success, something must be done to make teachers generally more scholarly. One cannot teach what he does not know. The idea that one teacher can correlate all of the various subject matter fields and teach them in the classroom is too ridiculous for comment here. It is another thing, however, for the teacher of mathematics to learn how to correlate informal geometry with arithmetic, algebra, or numerical trigonometry. It is not only possible but desirable to have the teacher of mathematics teach science, particularly some physics or mechanics, or both. There are many teachers who can bring out relations between mathematics and art, between mathematics and music, and so on, but generally speaking such teachers are rare. What we need is a careful and more scholarly approach to the solution of this problem of correlation.

9. *Teachers of mathematics in the colleges and universities need to take more interest in the work of the secondary schools.*

We have a few outstanding cases[8] of men and women in the colleges and universities who have taken great interest in the work of the secondary schools and in organizations of teachers in secondary schools, but for the most part many of these people do not know what is going on in the schools and some of them seem to care less. And this in spite of the fact that some of the same pupils that are being trained in the mathematics of the secondary schools are the same pupils who will sit at the feet of the college instructors in mathematics in the colleges and universities in the days ahead. There is great need for a better working understanding and cooperation between teachers of mathematics in the secondary schools and those of collegiate grade. W. D. R.

[7] See Reeve, W. D., "Mathematics and the Integrated Program." THE MATHEMATICS TEACHER, April, 1937.

[8] Witness the great interest of men like Professors Hedrick, Kasner, Mitchell, Slaught and others.

What Subjects Shall be Required?

FROM reports coming to this office, it appears that in some places in this country, particularly in the state of New York, a movement is on foot to require pupils in the secondary school to take four years work in the social studies, without requiring any work at all in mathematics. It strikes us that this is the wrong way to attack the problem. If any subject matter field is in need of further study among our people, the best interests of the country might be better secured by making it possible for pupils in the secondary school to study any of the great fields of knowledge like English, mathematics, science and social studies and the like throughout the four years. The amount to be studied in each case should depend upon particular needs. Nothing can be gained by creating rivalries between the teachers in the various fields. Intelligent cooperation in the education of our children is a much more sensible plan.

W. D. R.

◆ IN OTHER PERIODICALS ◆

By NATHAN LAZAR
Midwood High School, Brooklyn, New York

Bulletin of the Kansas Association of Teachers of Mathematics

February 1944, vol. 18, no. 3.

1. Ulmer, Gilbert, "The Importance of High School Mathematics for College Preparation," pp. 99–101.
2. "The Rafter Framing Square," pp. 101–103.
3. Tripp, M. O., "Teaching the Fundamentals of Mathematics," pp. 103–104.
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6. McDonald, Joe, "Geometric Representation of Hyperbolic Functions," p. 112.

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March 1944, vol. 44, no. 3.

1. Davis, H. T., "Archimedes and Mathematics," pp. 213–221.
2. Nyberg, Joseph A., "Notes from a Mathematics Class Room," pp. 270–273.
3. Carver, Harry A., "Air Navigation and the Secondary Schools," pp. 274–279.

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NEWS NOTES

INSTITUTE FOR MATHEMATICS TEACHERS

Grades 7–12

Duke University—East Campus

July 3–15

This is the fourth annual meeting of the Institute for Teachers of Mathematics. All who are interested in improving the work done in mathematics are invited to come and participate in the work of the Institute. Open discussion will be a feature of the daily programs. (Daily sessions at 11:00 A.M., 4:00 P.M., 8:15 P.M., registration fee $2.00, board and room $2.50 per day)

Unit I. July 3, 4, 5.

"Visual Aids in the Study of Mathematics" (six lectures)

Leader: Professor E. H. C. Hildebrandt, Professor of Mathematics Northwestern University.

Professor Hildebrandt is recognized throughout the nation for his work in this field.

Unit II. July 6, 7, 8.

"Air and Sea Navigation" (five lectures).

Leader: Professor F. G. Dressel, Mathematics Dept., Duke University.

Professor Dressel has been conducting courses in Navigation in the Navy Program at Duke University.

Unit III. July 4–14

"Mathematical Education" (nine lectures without conflict with other units) (Emphasis on war and post-war planning).

Leader: Miss Veryl Schult, Director of Mathematics in the High Schools of Washington, D. C. Miss Schult is well known in the councils of Mathematics Teachers.

Professors Hildebrandt, Schlauch, Scates, and others will assist Miss Schult in conducting this unit of work.

Unit IV. July 10, 11, 12

"Consumer Mathematics" (five lectures).

Leader: Professor W. S. Schlauch, Professor of Mathematics School of Commerce, New York University. Professor Schlauch is the author of books on Business Mathematics, and is widely known for his knowledge of the applications of mathematics to commerce and industry.

Mr. A. L. M. Wiggins, President of the American Bankers Association will address the Institute on July 12, 8:15 P.M.

Unit V. July 13, 14, 15

"Applications of Mathematics to Engineering" (five lectures).

Leader: Professor W. J. Seeley, Professor of Electrical Engineering) College of Engineering, Duke University.

Professor Seeley is known as author, teacher, and consultant.

Professor K. B. Patterson, Mathematics Department, Duke University will conduct "Observation Parties in Astronomy," July 7, 10, 11.

Bring or send *student-made* models, instruments, drawings, etc. for exhibit in the Mathematics Laboratory.

Headquarters for the Institute will be in the Mathematics Laboratory, West Duke Building, East Campus.

Detail programs will be issued about April 15. For information, write,

W. W. RANKIN, Duke University,
Director of Institute.

The sixth meeting of the Men's Mathematics Club of Chicago and the Metropolitan Area was held on Friday March 17, 1944. Professor Vernon V. Lippitt of the Technological Institute of Northwestern University spoke on "Mathematics for Engineers" and Professor Arthur Tebbutt of the College of Liberal Arts of Northwestern University spoke on "Statistical Standards."

Program Committee

H. C. Torreyson, Chairman, Lane Technical High School.

W. H. Kurzin, Herzl Junior College.

David Rappaport, Lane Technical High School.

Historian, C. M. Austin, Oak Park High School.

Officers 1943–1944

M. D. Oestreicher, Pres., Francis W. Parker School, Chicago, Ill.

Glenn F. Hewitt, Sec.-Treas., Von Steuben High School, Chicago, Illinois.

W. W. Barczewski, Rec. Sec., Waukegan Township High School, Waukegan, Illinois.

Exhibit Committee

Glenn L. Anderberg, Chairman, Waukegan Township High School.

John P. Esposito, Crane High School.

Hobert Sistler, Morton High School.

Dr. Rolland R. Smith former President of The National Council of Teachers of Mathematics has been made coordinator of mathematics for the junior and senior high schools in Springfield, Mass.

He will confer with mathematics teachers in these schools to unify the work and to make sure students are prepared for transition to secondary schools. He will also work in an advisory capacity with supervisors of the first six grades.

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